A REPORT ON PRELIMINARY CONSIDERATIONS OF SAMPLING PLAN DESIGN FOR THE HAT CREEK COAL DEPOSIT

A sampling plan cannot be designed to meet all eventualities unless those eventualities are specified. No such specifications have been forthcoming! Hence, the approach adopted at present has been to confine our efforts to characterizing the variability of different variables of Hat Creek coal on the basis of available data. Such data are available in reasonable abundance only for samples with core lengths of 20 feet or more (up to 100 to 200 feet), and, in the 20 to 40 foot range, for proximate data only.

Variability of analytical data is obviously a function of sample size. Long core samples, even 20 to 40 feet long for example, smooth out local variations that exist over distances of a few feet. An examination of local variability appears desirable because

(1) it is imperative in plant design to take into account local variability of feed that might be received in hoppers and subsequently in the furnace, and

(2) local variability studies provide the most fundamental basis on which to base an optimal sampling plan, where optimal refers to an acceptable tradeoff between certainty of estimations and cost.

It should be clear that item (1) above cannot be resolved only by core analyses, or any analyses that relate purely to *in situ* coal because the coal will be subjected to various homogenizing and segregating influences prior to introduction as furnace feed. However, knowledge of local variability is knowledge of the starting condition for the coal, a condition that can be estimated, and which provides a base of comparison for the effects that subsequent operations have on variability of the coal.

A second point that must be made clear is that we are concerning ourselves at present with samples of a particular support or supports. Support here means a particular size and shape of sample (e.g. one half of a 20-foot cylinder of drill core). The kind of variability observed in such samples does not bear any as yet established relationship to the kind of variability to be expected in a shovel scoop!

At the present phase of evaluation of Hat Creek coal a relatively wide-spaced drilling grid (eventually with holes on 500-foot centres) is anticipated. Such a spacing assumes that lateral variability of coal over distances less than 500 feet is negligible or at least is low relative to variability encountered along drill holes that cut layering in the coal at or near 90°. This assumption is not necessarily true for many variables even within the same gross stratum (A, B, C, or D) and the writer is presently examining lateral variability, as far as existing data permit, using analysis of variance.

A data base is required that will serve as a basis for designing a sampling plan that will provide information for mine and plant design. The writer, in conjunction with others, has come to the conclusion that such a data base could be provided by an absolute minimum of 2 drill holes that provide analytical data for all four major strata (A, B, C, and D). Each of these holes should provide information on each of the major strata but the two holes should be located such that they indicate something of the variability in a lateral sense. Because of geometric restrictions, difficulties of access, and locations of other holes already drilled, these holes cannot be chosen randomly. Two sites have been selected based on the above criteria and within the framework of the planned locations of holes at or near 500-foot centres. All samples from both these holes should be assayed for proximate, ultimate and ash elemental values, details of which need not be recorded here. Such a procedure has the considerable advantage that simple and multiple correlation studies among all groups of variables are possible at a variety of sample sizes.

The question of sample size (core length to be analyzed) is an important one for reasons of cost of analyses if none other. For plant design 5-foot samples are desired in the 2 test holes. Such a data base would certainly serve as a sound basis for designing a sampling plan and is to be recommended. A modification will be suggested based on the following discussion.

Examination of geological drill logs shows a surprising homogeneity of megascopic characteristics. Geophysical logs show appreciably more variability and, in many holes, permit the unambiguous recognition of 4 major strata, A, B, C and D, each characterized by its own variability of physical measurements (density, resistance, gamma radiation). An examination of zone A shows that there are several levels of extreme local variability, one on a scale of 1 to 2 feet, the next being at a scale of 15 to 20 feet. In this case 10-foot samples should provide equally good information as would 5-foot samples--both would smooth out the very small scale variations but both would indicate the 15 to 20-foot variation. Similarly, the two zones of relatively uniform coal, B and D, appear to have sufficiently uniform physical properties that little would be added to our knowledge of variability by using 5-foot samples instead of 10-foot samples. Zone C, on the other hand, is characterized by a short-range physical variability that would be smoothed out significantly by 10-foot samples and 5-foot samples are desirable.

This discussion of adequate sample lengths for a study of variability of various measured quantities is based on the realistic assumption that physical variations reflect lithologic variations which, in turn, reflect chemical variations. Put another way, the geometry (interlayered nature) of physical variables should also reflect the major component of the chemical variability. Although this is certainly true it must be remembered that even a well-defined lithological unit that is apparently homogeneous megascopically can have substantial variations of chemistry. To offset this problem the following approach to sample size for analysis is recommeded:

Zone A: Zone B: Zone D:	2 10-foot samples followed by 2 5-foot samples repeated as required
Zone C:	5-foot samples

Samples should be systematic.

The foregoing plan has been devised using geophysical and geological logs for drill holes near the sites of the two test holes. If logs are available from the test holes themselves prior to analyses being done, it is obviously more appropriate to refine the sampling plan using test hole logs as a guide. This option can be kept open by collecting 5-foot samples and combining some of them to form 10-foot samples prior to analysis.

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A.J. Sinclair
June 23, 1976

INTER AND INTRA LABORATORY REPRODUCIBILITY
HAT CREEK COAL ANALYSES

A total of 29 samples thus far have been split and analyzed in duplicate for proximate analyses. These pairs have been divided among laboratories as shown in Table I.

TABLE I

DISPOSITION OF REPLICATE SAMPLES

Laboratory Name	Symbol	No. of Pairs
General Testing	GT	8
Loring Laboratories	LL	10
Commercial Testing	CT	11
TOTAL		29

These paired data were analyzed using the general methodology described by Garrett (1969) and illustrated by the following equation

$$\sigma_A^2 = \frac{1}{N}\sum_{i=1}^{N}\frac{(X_{1i} - X_{2i})^2}{2}$$

where σ_A^2 is combined sampling and analytical variance

X_{1i} is value for a routine sample

X_{2i} is value for a replicate sample

N is the number of sample pairs.

Precision is quoted relative to the mean of the sample pairs as a percentage representing the 95 percent confidence range.

TABLE II

LABORATORY REPRODUCIBILITY

LAB	No. of Pairs	Variable	$\bar{x}$	S^2	S	Rel. Error 68%	95%
GT	8	Ash	41.48	.01218	.1104	.266	.53
		Vol.	32.24	.1396	.374	1.16	2.29
		F.C.	26.30	.170	.412	1.57	3.10
		Btu/#	6522.	34931.	187.	2.87	5.67
		S	0.498	.00875	.0935	18.8	37.2
LL	10	Ash	27.40	.4228	.650	2.37	4.7
		Vol.	38.94	6.312	2.512	6.54	13.00
		F.C.	33.62	3.887	1.972	5.86	11.61
		Btu/#	8522.	42525.	206.	2.42	4.79
		S	0.659	.00070	.0265	4.02	7.95
CT	11	Ash	38.27	.18734	.433	1.13	2.24
		Vol.	31.38	.22969	.479	1.53	3.02
		F.C.	30.345	.29348	.542	1.79	3.54
		Btu/#	7064.	4257.1	65.2	0.92	1.83
		S	0.727	.000236	.0154	2.12	4.19

$$\text{Precision} = \frac{1.98\ \sigma_A}{\bar{x}} \times 100$$

Results of the precision analysis are listed in Table II.

F tests at the 95% level indicate that significant and non-significant differences in precision occur as shown in Table III. To summarize these results briefly:

(a) No significant differences in precision of ash determinations can be recognized.

(b) GT and CT measure volatiles with similar precision but both are significantly different than LL.

(c) CT and LL have the same precision for Sulphur but both are significantly different than GT.

As a means of ranking the labs assign one point to each lab for each of the 4 variables that are measured with better precision than other labs, and zero if the precision is poor compared with other labs. The following table is obtained:

	Ash	Vol	Btu	S	Total
CT	1	1	1	1	4
GT	1	1	0	0	2
LL	1	0	0	1	2

With present data on reproducibility there is little question that CT is consistent for the most variables. However, this approach tells us nothing about systematic differences between labs!

TABLE III

F-TESTS FOR REPRODUCIBILITY

Variable	Labs Compared	F	Significant
Ash	G.T. vs C.T.	.6502	No
	G.T. vs L.L.	.2881	No
	C.T. vs L.L.	.4431	No
Volatiles	G.T. vs C.T.	.6078	No
	G.T. vs L.L.	.02212	Yes
	C.T. vs L.L.	.03634	Yes
B.t.u./lb.	G.T. vs C.T.	8.21	Yes
	G.T. vs L.L.	.82142	No
	C.T. vs L.L.	.1001	Yes
%S	G.T. vs C.T.	3.708	Yes
	G.T. vs L.L.	12.5	Yes
	C.T. vs L.L.	.3371	No

All tests done at 95% level.

Degrees of freedom are GT (7), CT (10) and LL (9).

ADDENDUM TO TABLE IV

PARAMETERS OF DATA USED FOR
INTERLAB COMPARISONS

Lab Pair*	Variable	N	$\bar{X}_1$	S_1	$\bar{X}_2$	S_2
GT vs LL	Ash	102	43.69	13.98	43.65	**
(1) (2)	Btu	102	6279.	4380.	6226.	2169.
	S	101	0.59	0.24	0.65	0.25
	Vol.	76	31.14	5.71	29.99	6.27
CT vs GT	Ash	104	43.80	14.23	43.59	14.15
(1) (2)	Btu	104	6254.	2138.	6303.	2076.
	S	104	0.59	0.25	0.60	0.27
	Vol.	78	28.99	5.54	31.17	5.72
CT vs LL	Ash	117	42.80	14.48	42.45	14.42
(1) (2)	Btu	117	6404.	2156.	6400.	2228.
	S	117	0.59	0.26	0.74	0.97
	Vol.	117	29.61	5.62	30.42	6.17

* Numbers beneath lab symbols refer to subscripts to parameters.

** Value lost accidently during calculation.

TABLE IV

INTERLABORATORY PRECISION

	Variable	N	$\bar{x}$	S^2	S	Rel. Dif. 68%	Rel. Dif. 95%
GT vs LL	Ash	102	43.67	.05954	.244	.56	1.11
	Btu/#	102	6253.	67859.	260.5	4.17	8.25
	S%	102	0.622	.00221	.047	7.56	14.97
	Vol	76*	30.57	1.63	1.28	4.19	8.29
CT vs GT	Ash	107	43.75	1.1129	1.055	2.41	4.77
	Btu/#	104	6277.	72871.	269.9	4.30	8.51
	S%	104	.603	.00160	.040	6.63	13.13
	Vol	78*	30.05	3.15	1.77	5.89	11.66
LL vs CT	Ash	117	42.63	.3436	.586	1.38	2.73
	Btu/#	117	6400.	19606.	446.8	6.98	13.82
	S%	117	0.625	.00410	.064	10.25	20.29
	Vol	117	29.96	2.81	1.68	5.61	11.10

* Gross systematic errors were evident in earliest 26 volatile analyses by G.T. and these results have been omitted from this statistical study.

SIGNIFICANCE OF INTERLAB COMPARISONS

More than 100 samples have been analyzed by all or 2 of the labs dealt with here. Paired analyses from two labs can be compared using a formula similar to that on page 1 of this report, the error in this case referring to the interlab variability. An indication of the relative error of duplicate samples analyzed in different laboratories is given in Table IV. These data can be used in conjunction with data from Table II to carry out F tests that compare precision for a variable with interlab precision. This has been done at the 95% level for the 3 variables in Table IV, and for all possible pairs of laboratories. Results are tabulated in Table V. In general, the interlab variability should be indistinguishable from precision, otherwise one of two possibilities might provide an explanation--first, the internal precision of one of the labs is very much different than for the other lab in the comparison, and secondly, a systematic error exists between the two labs.

On the foregoing basis the following conclusions can be derived from Table V:

(1) GT analyzes ash with a systematic difference relative to both CT and LL.

(2) CT appears to measure Btu's with a systematic difference relative to LL.

(3) There are large interlaboratory variances for sulphur for all paired labs. Which one is the best cannot be determined from available data but should depend on analysis of known standards.

TABLE V

COMPARISON OF PRECISION AND INTERLAB VARIABILITY

Variable	Source of Variance	d.f.	S^2	F	Remarks*
Ash	GT vs LL	101	.05954		Both precisions
	GT	7	.01218	.2046	different than
	LL	9	.4228	7.10	interlab variations
	CT vs GT	106	1.1129		Both precisions
	CT	10	.1873	5.94	different than
	GT	7	.01218	91.4	interlab variations
	LL vs CT	116	.3436		No significant
	LL	9	.4228	.813	differences
	CT	10	.1873	1.834	
Btu/lb	GT vs LL	101	67859.		No significant
	GT	7	34931.	1.94	differences
	LL	9	42525.	1.60	
	CT vs GT	103	72871.		CT precision differs
	GT	7	34931.	2.09	from interlab varia-
	CT	10	4257.	17.1	tions
	LL vs CT	116	19606.		Both precisions
	LL	9	42525.	0.448	are different than
	CT	10	4257.	4.61	interlab variations
Sulphur	GT vs LL	101	.00221		Both precisions are
	GT	7	.00875	.253	different than
	LL	9	.00070	12.5	interlab variations
	CT vs GT	103	.00161		Both precisions are
	CT	10	.000236	6.82	different than
	GT	7	.00875	0.18	interlab variations
	CT vs LL	116	.00410		Both precisions are
	CT	10	.000236	17.37	different than
	LL	9	.00070	5.9	interlab variations

* F tests are done at the 95% level.

TABLE V (Cont'd)

COMPARISON OF PRECISION AND INTERLAB VARIABILITY

Variable	Source of Variance	d.f.	S^2	F	Remarks*
Volatile	GT vs LL	75	1.63		Both precisions
	GT	7	0.140	.0859	different than
	LL	9	6.31	3.87	interlab variations
	CT vs GT	77	3.15		Both precisions
	CT	10	.230	.0730	different than
	GT	7	0.140	.0444	interlab variations
	CT vs LL	116	2.81		Both precisions
	CT	10	.230	.0819	different than
	LL	9	6.31	2.246	interlab variations

* F tests are done at the 95% level.

CONCLUSIONS

1. CT consistently shows good precision relative to LL and GT for proximate data.
2. All labs measure sulphur with poor interlab precision although internal precision of GT is better than 5 percent at the 95 percent level. Standards that span the range of expected results should be submitted in sufficient quantity to establish accuracy of sulphur analyses by all labs.
3. Internal precision for % Ash is better than 5 percent for all labs; interlab precisions for % Ash is better than 5 percent for all pairs of labs (all at the 95 percent level).
4. Internal lab precision for Btu/# is less than 6 percent (95 percent level) for all labs but the paired precision is substantially worse (8 to 14 percent).
5. The possibility of systematic differences between labs for certain analyses exists: GT appears to analyze ash with a systematic difference relative to both CT and LL; CT appears to measure Btu's with a systematic difference relative to LL. Analyses of standards must be done to determine which lab has the best accuracy in the foregoing cases.
6. A general arbitrary ranking scheme shows that CT provides consistently good analytical results if the 95 percent level is used as a testing criterion.

A.J. Sinclair
July 12, 1976

AN EVALUATION OF PRE-1976 PROXIMATE ANALYSES
NO. 1 DEPOSIT, HAT CREEK COAL

INTRODUCTION

This study has been undertaken to evaluate results of previous analytical work, to examine the homogeneity of data throughout the proposed No. 1 pit area, and to provide some insight into treatment of detailed analytical data to be forthcoming shortly for holes 76-135 and 76-136.

Several computer retrievals were made from the Hat Creek data file as specified by the writer. These retrievals were done by Mr. Dick Andrews of the Operations Research Group with the concurrence of Mr. Tony Angel, Director. Computer output includes:

(1) Listings and statistical summaries of data for separate stratigraphic zones (A, B, C and D) within the No. 1 pit area. For this purpose data were grouped by sample lengths as follows: 5±2, 10±2, 20±3, 30±3 and 40±4. Variables studied in the above groupings are based on dry weights: Ash %, Vol. Matter %, Fix. C%, Btu/#, and Sulphur (%).

(2) Histograms for foregoing variables for all groupings for which the number of values exceeded 9.

(3) Listings of cumulative histogram data for all groupings in 2 above.

The most relative of these data are summarized in convenient form in Tables I to VI inclusive which form the basis of this report.

EVALUATION OF DATA

Data used come from the analyses available for No. 1 deposit. Only sample lengths up to 40 feet were considered. Statistics for all 5 sample lengths are recorded but it would appear that those based on a sample size less than about 30 are of dubious value. The assumption is made that a sample size of 30 or more is representative of the No. 1 pit. This would appear to be the case as will appear in a subsequent discussion of sample variability as a function of sample length.

Ash analyses are biased towards high values because they are used as a basis for selecting samples for further analysis. On a dry basis samples with ash values greater than 75% are not analyzed routinely for other variables. This bias is particularly evident for short sample lengths (5 and 10 feet). To offset this problem a second set of "mean values" for Ash % have been calculated from the formula:

$$\text{Ash \%} = 100 - \text{Volatile Matter (\%)} - \text{Fixed Carbon (\%)}$$

and are recorded in Table VI.

PRESENTATION OF STATISTICAL DATA

Data are summarized as statistics in Tables I to VI inclusive. Tables I to V inclusive are arranged for ease of visual evaluation of (1) variation of variability (statistical dispersion) as a function of sample length for individual stratigraphic zones (A, B, C and D), and (2) comparison of variability from one stratigraphic zone (A, B, C or D) to another for constant sample length. Table VI shows variations in weighted mean values for all variables as a function of stratigraphic zone.

CONCLUSIONS

(1) For the most part there are not enough samples of all lengths to examine in detail the relation of variability to sample length.

(2) Ash--10-foot samples show substantially more variability than 20-foot, 30-foot or 40-foot samples (which show similar variability) for A-, C- and D-zones. Data for B-zone are inadequate.

(3) Volatile Matter--A zone shows a regular decrease in variance with increase in sample length. B-zone data are inadequate but the one sample length (20 feet) with substantial values (n = 35) shows variability somewhat akin to D-zone data. C-zone data are inadequate but 20-foot and 30-foot samples show variability similar to A-zone. D-zone data for 20-, 30- and 40-foot samples show comparable variability. Data for shorter samples are inadequate.

(4) Btu/#--A-zone data show fairly good decrease in variability with increase in sample size. B-zone data are inadequate but 20-foot sample lengths have a variability comparable with D-zone. C-zone data are inadequate but variability is high, akin to A-zone as indicated by sample data for lengths of 20 and 30 feet. D-zone data show similar variability for 20-, 30- and 40-foot samples but data for smaller sample lengths are inadequate.

(5) Sulphur--A-zone shows significantly lower variability for 20- and 30-foot sample lengths than for 10-foot lengths. B-zone data are inadequate but variability is low for 20-foot samples. C-zone sulphur shows comparable high variability in 20-, 30- and 40-foot samples but data for shorter sample lengths are inadequate. D-zone data show a regular decrease in variability for 20-, 30- and 40-foot samples. Data for 5- and 10-foot samples are inadequate.

(6) Summary by Zones: A-zone data show an evident decrease in variability between 10- and 20-foot sample lengths. The data indicate little difference in variances for sample lengths of 20, 30 and 40 feet for all variables although there is a slight tendancy for variance to decrease with increasing sample length (as might be expected).

Little can be said regarding sample length in the B-zone because adequate data are available only for 20-foot lengths. The statistics for this length compare with equivalent data from the D-zone.

C-zone data are adequate only for 20- and 30-foot samples and variability of 20-foot samples is consistently higher than for 30-foot samples for all variables.

D-zone has adequate data for 20-, 30- and 40-foot samples all of which show comparable variances for Ash, Volatile Matter, Fixed Carbon and Btu/#. Sulphur has a low variance but shows an abrupt decrease between 20- and 30-foot sample lengths.

(7) Available data suggest that for proximate data 20-, 30- and 40-foot samples provide very comparable indications of variability; and, of course, they are more-or-less comparable as an estimator of the mean. Where adequate data exist there is an indication of slight decreases in variances as sample lengths increase from 20 to 40 feet.

(8) Data are inadequate to evaluate the usefulness of 5- and 10-foot sample lengths as indicators of short range variability.

(9) Evaluation of mean values (Table VI): Extreme differences between means of all zones and the grand average for each of the variables is apparent by examination of Table VI. Note, in particular, the following:

1. Grand average values for any variable give little real indication of what exists in individual zones.
2. Sulphur is noticeably much higher (nearly twice as high) in zones A and B compared with zones C and D.
3. Zones C and D show greatest contrast for Btu/#, Fixed Carbon, Volatile Matter and Ash. Each of these variables except for Volatile Matter differ by a factor of 2 between these two zones.

4. A and B zones have intermediate values for Btu/#, Volatile Matter, Fixed Carbon and Ash, and, in fact, the two zones are very similar with the proviso that zone A is systematically of lower quality than zone B in all variables considered here.

A. J. Sinclair, P. Eng
Aug. 18, 1976

TABLE I: ASH (DRY %)

SUMMARY STATISTICS FOR PRE-1976 DRILL DATA

		Sample length (feet)				
		5	10	20	30	40
ALL	n	46	57	280	109	50
	$\bar{x}$	83.7	68.5	42.8	42.1	34.0
	s	23.4	29.8	21.2	21.1	21.0
A	n	31	36	96	26	7
	$\bar{x}$	87.0	67.0	49.9	48.6	48.7
	s	22.0	30.4	22.7	20.7	24.2
B	n	0	0	35	10	3
	$\bar{x}$			35.2	40.4	33.6
	s			7.4	13.5	1.0
C	n	4	7	59	23	6
	$\bar{x}$	78.9	73.3	54.6	51.0	63.9
	s	24.4	25.9	10.9	11.5	23.6
D	n	1	3	74	40	31
	$\bar{x}$	25.75	25.1	23.8	25.8	23.0
	s	–	10.1	7.4	7.5	6.9

TABLE II: VOLATILE MATTER (DRY %)

SUMMARY STATISTICS FOR PRE-1976 DATA

		Sample length (feet)				
		5	10	20	30	40
ALL	n	18	33	260	101	47
	$\bar{x}$	24.2	30.1	31.9	31.7	34.5
	s	7.8	6.4	5.7	5.5	4.8
A	n	10	21	83	23	6
	$\bar{x}$	23.1	31.1	30.6	30.9	32.0
	s	7.9	5.6	4.9	3.5	3.1
B	n	0	0	35	10	3
	$\bar{x}$			33.4	31.2	33.4
	s			3.4	6.1	1.0
C	n	2	4	58	23	4
	$\bar{x}$	30.5	27.9	26.2	26.6	25.2
	s	4.2	1.9	4.2	5.7	6.1
D	n	1	3	74	40	31
	$\bar{x}$	34.2	35.0	36.8	35.3	36.4
	s	-	5.6	2.9	3.3	3.0

TABLE III: FIXED CARBON (DRY %)

SUMMARY STATISTICS FOR PRE-1976 DATA

		Sample length (feet)				
		5	10	20	30	40
ALL	n	18	33	260	101	47
	$\bar{x}$	17.4	24.4	29.6	30.8	35.7
	s	11.9	10.9	9.4	9.2	8.9
A	n	10	21	83	23	6
	$\bar{x}$	17.3	25.4	27.3	27.2	27.9
	s	11.8	10.1	7.3	5.7	6.5
B	n	0	0	35	10	3
	$\bar{x}$			31.4	28.3	33.0
	s			5.0	7.5	1.1
C	n	2	4	58	23	4
	$\bar{x}$	11.7	18.8	20.0	22.4	19.9
	s	5.9	9.0	5.8	7.2	8.3
D	n	1	3	74	40	31
	$\bar{x}$	40.0	39.9	39.4	39.0	40.6
	s	-	4.5	5.5	5.4	4.5

TABLE IV: Btu/# (DRY)

SUMMARY STATISTICS FOR PRE-1976 DATA

		Sample length (feet)				
		5	10	20	30	40
ALL	n	18	33	260	101	47
	$\bar{x}$	4066	5884	7020	7162	8381
	s	2790	2535	2204	2096	1989
A	n	10	21	83	23	6
	$\bar{x}$	4131	6110	6477	6445	6927
	s	2778	2383	1660	1283	1457
B	n	0	0	35	10	3
	$\bar{x}$			7439	6831	7826
	s			1105	1922	128
C	n	2	4	58	23	4
	$\bar{x}$	2413	4408	4653	5094	4536
	s	2440	1769	1389	1674	2068
D	n	1	3	74	40	31
	$\bar{x}$	9041	9328	9291	8975	9437
	s	-	1536	1163	1184	1075

TABLE V: SULPHUR (DRY %)

SUMMARY STATISTICS FOR PRE-1976 DATA

		Sample length (feet)				
		5	10	20	30	40
ALL	n	18	33	260	101	47
	$\bar{x}$	.54	.641	.515	.445	.407
	s	.375	.471	.327	.324	.244
A	n	10	21	83	23	6
	$\bar{x}$	.639	.770	.692	.673	.707
	s	.423	.504	.232	.304	.144
B	n	0	0	35	10	3
	$\bar{x}$			.612	.680	.857
	s			.146	.232	.078
C	n	2	4	58	23	4
	$\bar{x}$	.245	.363	.403	.438	.300
	s	.149	.207	.291	.414	.099
D	n	1	3	74	40	31
	$\bar{x}$	.44	.443	.330	.259	.300
	s	–	.142	.240	.130	.121

Table VI

Weighted Averages of All 5 to 40-foot Samples
By Stratigraphic Zone. Hat Creek Coal Deposit

VARIABLE	ZONE A	B	C	D	ALL
Ash (dry %)*	58.7	36.2	53.8	24.2	48.0
Ash (calc'd)**	43.4	36.2	53.2	24.1	38.7
Vol. Mat (dry %)	30.3	32.9	26.4	36.3	31.7
Fix C. (dry %)	26.3	30.9	20.4	39.6	29.6
Btu/#	6273	7337	4699	9236	6993
S (dry %)	0.70	0.72	0.40	0.31	0.50

* Average value determined from assay data - includes many high ash values for which other proximate analyses were not done.

**Calculated from the equation (100 - $\overline{\text{Vol. mat.}}$ - $\overline{\text{Fix. C}}$) to provide a figure to the same sample base as all other variables in the table.

September 24, 1976.

Mr. Conrad Guelke, Manager,
Generation Planning Dept.,
B.C. Hydro & Power Authority,
700 West Pender Street,
Vancouver, B.C.
V6C 2S5

Dear Mr. Guelke:

HAT CREEK DEVELOPMENT
REPORT BY DR. A.J. SINCLAIR

Enclosed is a brief report, dated September 20, 1976, by Dr. A.J. Sinclair on proximate analysis, calorific value and total sulphur data for special holes 76-135 and 136. The report is restricted to the above-mentioned analyses because data is still incomplete for other analyses from those drill holes.

Dr. Sinclair has stated verbally that based on his assessment of the available data, it would be statistically acceptable to increase the maximum permissable sample length from 20 to 40 feet. However, he is not prepared to recommend that this be done until he has had the opportunity to assess the ultimate, ash analysis, etc. data.

Yours truly,

DOLMAGE CAMPBELL & ASSOCIATES LTD.

Lisle T. Jory

LTJ/jd
Enclosures - 2
cc: Mr. M.H. French (1)
Mr. R. Merer (2)
Mr. N. Krpan (2)
Dr. A.J. Sinclair (1)

HAT CREEK DEVELOPMENT

INTERIM REPORT ON DRY PROXIMATE ANALYSES

OF TEST HOLES 135 AND 136

Statistical parameters for dry proximate data for drill holes 135 and 136 are summarized in Tables I and II. An evaluation of these data along with probability plots and semivariograms of all the variables produce the following preliminary conclusions.

1. Statistical parameters (mean and standard deviation) for all variables are indistinguishable at the 95% confidency level from one hole to the other, with the exception of B-zone ash.

2. This apparent uniformity over a distance of 1000 feet should be interpreted as applying only to parts of the coal that can be divided into zones (A, B, C or D) unabiguously. Greater variations are to be expected in areas of greater geological complexity such as areas of pronounced facies changes or faulting.

3. The principal variability in proximate data is along the lengths of drill holes (i.e. across the layering of the coal beds) as opposed to along the layering. This across-strata variability appears to be a reasonable first approximation of 3-dimensional variability that can be used for design purposes.

4. Dispersions (standard deviations) are shown in Figure 1 as a function of sample lengths. These variations in dispersion closely approximate an exponential form by empirical observation (i.e. a linear plot on log paper), which can be used for interpolation (e.g. to study expected variability of blocks 13' x 13' x 13' which approximate 100 tons of production).

5. An examination of cumulative probability plots shows that each proximate variable except total sulphur has a density distribution that can be approximated by a single normal distribution or a combination of two normal distributions. Total sulphur values approximate a lognormal distribution.

6. Experimental semivariograms constructed for each of the variables for *each hole separately and for each zone separately show that only a* few variables can be treated to advantage for estimation purposes using such techniques for data from holes spaced at 500 feet or more. In *general the semivariograms show that most variables can be treated as* random. Some variables show a drift or trend but these only become significant for sample spacings in excess of 80 feet.

Dr. A.J. Sinclair, P.Eng.
September 20, 1976

TABLE 1

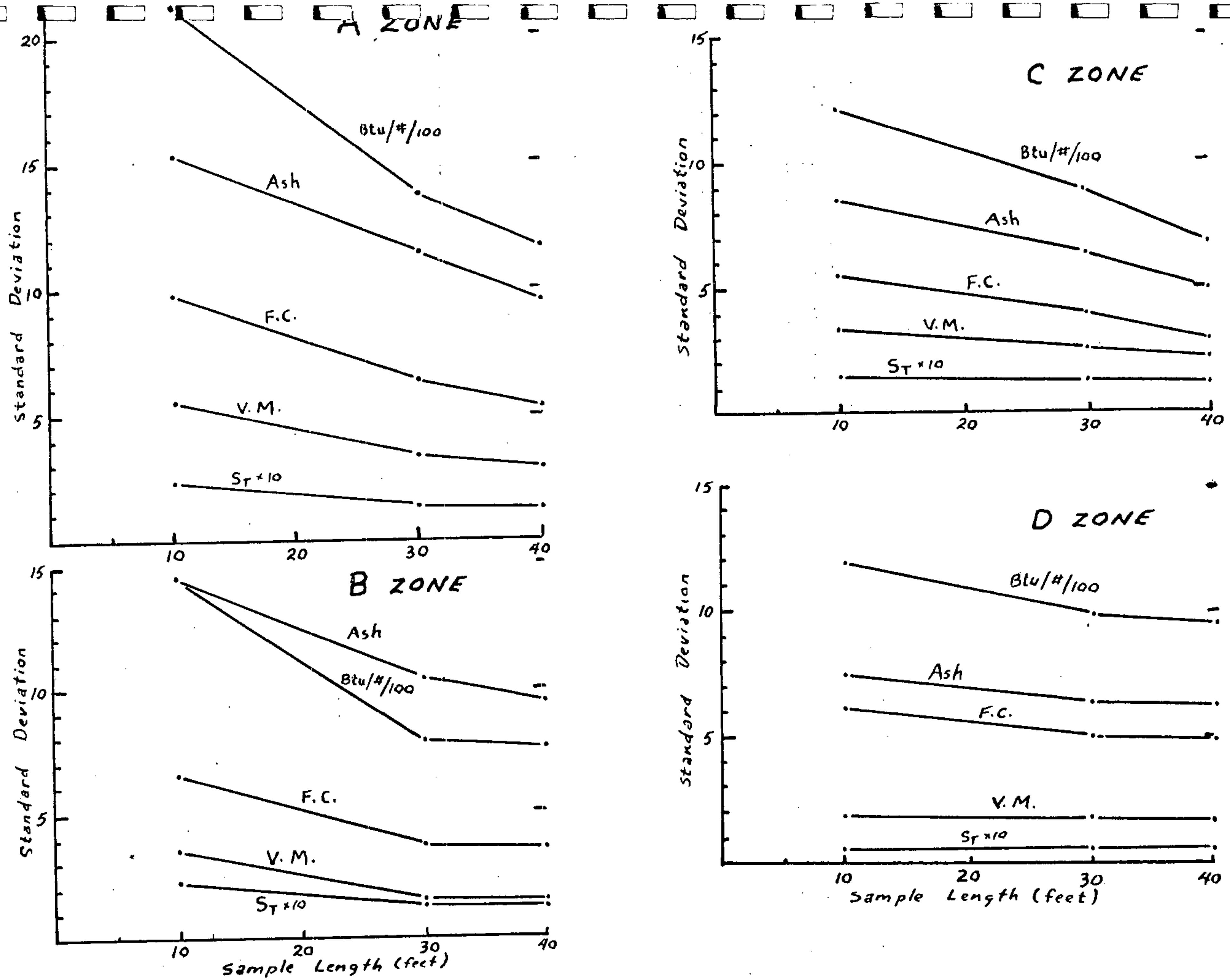
COMPARISON OF STATISTICAL PARAMETERS FOR TEST HOLES 135 AND 136 FOR DRY PROXIMATE ANALYSES

Zone	Variable	DDH 135			DDH 136		
		n	x	s	n	x	s
A	Btu/#	54	6415	2068	54	6227	2176
	Ash	54	42.92	14.00	56	45.68	16.41
	F.C.	54	27.46	9.54	54	26.15	10.01
	V.M.	54	29.63	5.08	54	29.41	5.78
	S total	54	0.680	0.244	54	0.671	0.383
B	Btu/#	24	7679	1229	26	7639	1645
	Ash	24	34.84	8.35	26	40.34	17.72
	F.C.	24	33.78	5.69	26	33.78	7.45
	V.M.	24	31.37	3.24	26	31.48	3.88
	S total	24	0.792	0.190	26	0.817	0.256
C	Btu/#	22	4111	1567	15	4924	1731
	Ash	22	58.42	10.46	15	51.83	10.48
	F.C.	22	17.31	7.38	15	21.59	7.53
	V.M.	22	24.27	4.49	15	26.58	3.58
	S total	22	0.377	0.163	15	0.402	0.192
D	Btu/#	25	9211	1371	29	9665	1010
	Ash	25	25.99	8.65	29	22.17	6.36
	F.C.	25	41.10	6.86	29	42.44	5.06
	V.M.	25	32.91	2.45	29	35.39	1.81
	S total	25	0.231	0.067	29	0.296	0.061

TABLE 2

STATISTICAL PARAMETERS FOR DRY PROXIMATE DATA
FOR VARIOUS SAMPLE LENGTHS - HOLES 135-136 COMBINED

Zone	Variable	10-foot samples			30-foot samples			40-foot samples		
		n	x	s	n	x	s	n	x	s
A	Btu/#	108	6321	2115	98	6462	1374	94	6469	1162
A	Ash	108	44.32	15.27	102	43.68	10.48	100	44.03	9.58
A	F.C.	108	26.80	9.75	98	27.48	6.36	94	27.54	5.35
A	V.M.	108	29.52	5.42	98	29.80	3.36	94	29.77	2.92
A	S total	108	0.676	0.320	98	0.653	0.190	94	0.647	0.159
B	Btu/#	50	7658	1446	58	7733	795	43	7699	762
B	Ash	50	37.90	14.48	63	36.75	10.42	47	36.78	9.47
B	F.C.	50	33.78	6.60	58	34.03	3.82	43	33.88	3.65
B	V.M	50	31.43	3.55	58	31.73	1.61	43	31.63	1.49
B	S total	50	0.805	0.225	58	0.812	0.136	43	0.810	0.129
C	Btu/#	35	4413	1653	28	4479	891	25	4418	681
C	Ash	37	55.75	10.83	28	55.34	6.24	25	55.77	4.95
C	F.C.	35	19.06	7.64	28	19.56	3.96	25	19.36	3.01
C	V.M.	35	25.21	4.25	28	25.10	2.66	25	24.88	2.20
C	S total	35	0.387	0.173	28	0.361	0.130	25	0.352	0.115
D	Btu/#	54	9455	1201	66	9548	984	48	9533	961
D	Ash	54	23.94	7.68	66	23.32	6.32	48	23.40	6.10
D	F.C.	54	41.82	5.94	66	42.17	5.00	48	42.07	4.90
D	V.M.	54	34.24	2.45	66	34.51	1.73	48	34.52	1.67
D	S total	54	0.266	0.071	66	0.260	0.054	48	0.258	0.052


A ZONE
Btu/#/100
Ash
F.C.
V. M.
S_T ×10
Standard Deviation
5
10
15
20
10
20
30
40
B ZONE
Ash
Btu/#/100
F.C.
V. M.
S_T ×10
Standard Deviation
Sample Length (feet)
5
10
15
10
20
30
40
C ZONE
Btu/#/100
Ash
F.C.
V.M.
S_T ×10
Standard Deviation
5
10
15
10
20
30
40
D ZONE
Btu/#/100
Ash
F.C.
V. M.
S_T ×10
Standard Deviation
Sample Length (feet)
5
10
15
10
20
30
40