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INTERIM REPORT
EVALUATION OF SUPPLEMENTAL TOWERS - UPVALLEY LOCATIONS AT SUSQUEHANNA STEAM ELECTRIC STATION FOR PENNSYLVANIA POWER & LIGHT COMPANY

JULY 15, 1982
4894-078-09

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July 15, 1982

Pennsylvania Power & Light Company
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Allentown, Pennsylvania 18101

Attention: Mr. Tom Widner

Gentlemen:

Re: Evaluation of Supplemental Towers - Upvalley Locations at Susquehanna Steam Electric Station

We are pleased to submit five (5) copies of Dames & Moore's evaluation of the supplemental towers at the two upvalley locations for the Susquehanna Steam Electric Station. As soon as additional meteorological monitoring has been completed at the new downvalley location, we will complete our evaluation of the downvalley sites and prepare a revised report covering the entire supplemental tower study.

Please call if you have any questions or comments regarding this report.

Very truly yours,

DAMES & MOORE

Robert G. Allen
Partner

James R. Stogner
Senior Meteorologist

RGA:JRS:jms
Enclosure

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1.0 INTRODUCTION

The supplemental tower study was undertaken with three primary objectives in mind:

- Determine the validity of the Dames & Moore subjective model;
- Determine if supplemental meteorological towers are needed at the Susquehanna Steam Electric Station (SSES); and
- If permanent supplemental towers are needed, determine the best locations for these towers.

To accomplish the objectives of the study, a meteorological monitoring network was established by PP&L. Assistance in determining site locations was provided by Dames & Moore. The available site locations, both upvalley and downvalley from the SSES, were limited on the basis of exposure, topographic considerations, and site accessibility. Eventually, four sites were chosen for the study; see Figure 1. Sites 1 and 2 were located downvalley from the SSES and Sites 3 and 4 were located upvalley. Approximate site elevations were as follows:

Site 1	640' MSL
Site 2	940' MSL
Site 3	500' MSL
Site 4	500' MSL

Comparatively, the primary tower at the SSES is located at about 620' MSL.

At each site, a mechanical weather station was installed on top of a 10 m pole. Wind speed and wind direction were measured at each site for about a three-month period (11/11/81-02/17/82). Data reduction was performed by Dames & Moore. Wind speed was reduced to the nearest tenth of a mile per hour and wind direction was reduced to the nearest 10 degrees. Hourly wind speeds less than 0.5 mph were considered to be calms and hours where considerable wind direction meander occurred were logged as variable. Primary tower wind data at the 10-m level were also processed. Periods of missing data at the primary tower and at each

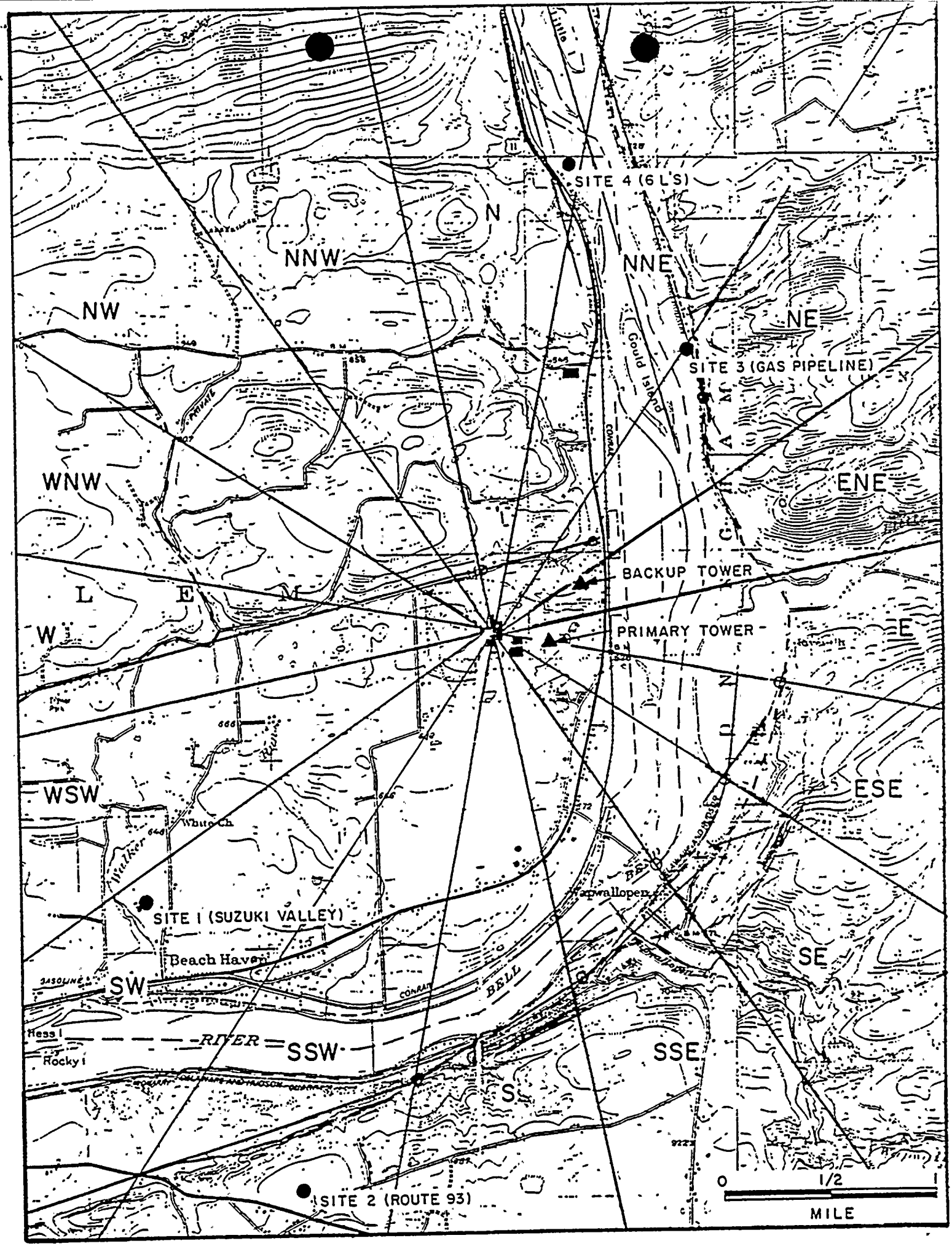


Figure 1. Location of Mechanical Weather Station Sites for Supplemental Tower Study.

supplemental towers are shown in Figure 2. These periods are based on wind direction data, but differ little for wind speed data.

The final phase of the study was a comparison of wind data at each supplemental tower site to wind data at the primary tower. Wind frequency distributions and scatter diagrams were used for this comparison. Evaluations were made in terms of the validity of the Dames & Moore subjective model and the need for permanent supplemental towers at the SSES.

Since preliminary analyses of the downvalley data indicated a need for additional monitoring, this study presents results for the upvalley monitoring sites only.

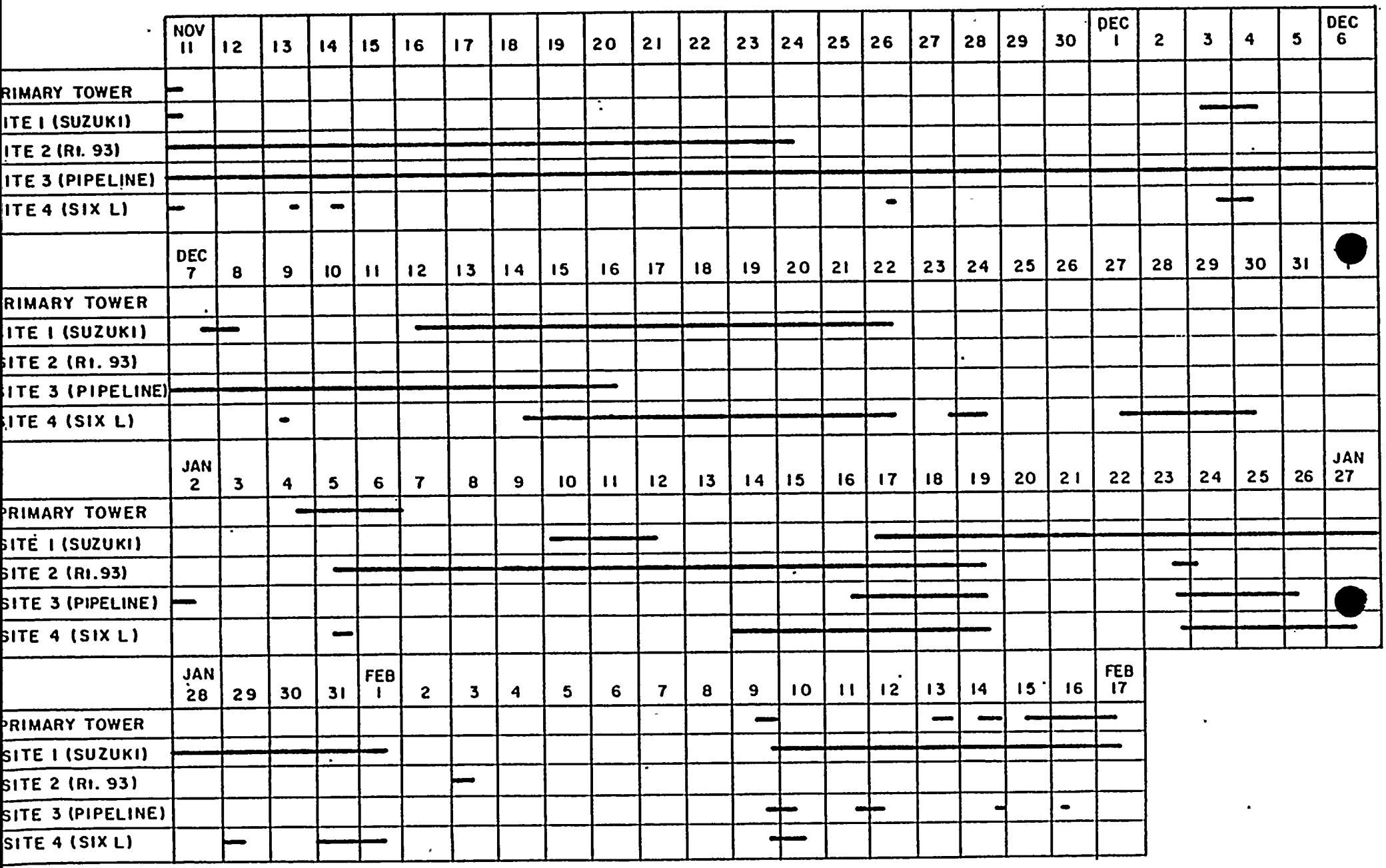


Figure 2. Missing or Invalid Data Periods

2.0 DESCRIPTION OF SUBJECTIVE MODEL

A description of the subjective model developed by Dames & Moore to account for the influence of abrupt elevation changes on transport and dispersion of plumes from the SSES is presented herein. This description provides the background information necessary to determine the validity of the subjective model.

Basically, a correction to the directional transport of the plume centerline is made for wind speeds less than two meters/second and stable atmospheric conditions (Pasquill stabilities E, F, and G) to account for the influence of abrupt elevation changes on the local wind circulation patterns. It is assumed that the plume will remain confined to the river valley when it encounters a steep rise in ground elevation. This gives rise to three basic types of stable, light-wind speed flow adjustments.

For S, SSW, and SW wind directions at the primary tower (upvalley case), the plume centerline is assumed to be confined to the center of the narrow river valley (about 600 meters wide) with σ_y restricted to, at most, 150 meters. No limit, however, is applied to the vertical dispersion coefficient, σ_z. An initial SW wind direction is assumed; then at the southern tip of Gould Island, the wind is assumed to shift to a S to SSE flow and thereafter remain in the river valley out to a radial distance of 10 miles from the SSES. To account for the deviation from straight-line transport caused by restricting the plume to the river valley, corrections to the positions of the plume centerline and off-centerline concentrations are made through the use of coordinate transformations at appropriate distances along the plume.

For WNW, NW, NNW, N, NNE, and NE wind directions at the primary tower (downvalley case), the plume is assumed to be transported to within a specific distance (depending on the initial wind direction) of the southern river valley wall and then transported downvalley in a direction of 260 (wind direction from 080). This causes the plume centerline to remain roughly parallel to the river valley wall at a distance of approximately 1000 meters. Since the valley in this direction is quite wide, no limitation is placed on σ_y. As in

the case of upvalley flow, appropriate coordinate transformations are used to account for plume bending.

Since the plume is already within 1000 meters of the contraining northern valley wall for E, ESE, SE, and SSE wind directions at the primary tower, an initial ENE wind direction is assumed (which would transport the plume downvalley roughly parallel to the valley wall). As in the case of the downvalley flow case, no limitation is placed on σ_y. However, no coordinate transformations are necessary.

All other stable, light-wind conditions (wind directions ENE, WSW, and W) encounter no abrupt changes in topography; therefore, no terrain corrections are necessary.

Only the upvalley flow case will be evaluated in this report.

3.0 COMPUTER ANALYSIS

Two types of computer analyses were performed in order to provide the comparative statistics required to evaluate the validity of the Dames & Moore subjective model and the need for permanent supplemental towers at the SSES. First, wind frequency distributions were developed by wind sector and wind speed intervals. These distributions were made for each supplemental tower site and the primary tower. Secondly, wind sector scatter diagrams were developed based on concurrent hourly data at each supplemental tower site versus the primary tower. These wind direction comparisons were developed for all observations and for stable atmospheric conditions only. Due to the lack of valid stability data at the primary tower during all of the study period, stable occurrences were assumed for all nighttime hours (hours 18-07, where 07 is defined as 0700-0800).

In addition, wind direction scatter diagrams were also developed for specified wind direction (at 10° intervals), wind speed, and time restrictions. Scatter diagrams applicable to the upvalley case are as follows (see Appendix A):

1. Wind direction at primary tower restricted to 160-220; wind speed at primary tower restricted to 4.5 mph or less; hours restricted to 1800-0700 (Case 1).
2. Wind direction at primary tower restricted to 160-220 (Case 2).
3. Wind direction at Site 4 restricted to 260-310 (Case 3).
4. Wind direction at primary tower restricted to 230-310 (Case 4).

4.0 RESULTS

Wind frequency distributions for the primary tower and Sites 3 and 4 are presented in Tables 1, 2, and 3, respectively. It should be noted that these distributions are not based on concurrent observations; but on the total number of valid observations at each site; see Figure 2.

A review of Table 1 indicates that the predominant wind directions at the primary tower during the study period were W and WSW with few occurrences from the ESE, SE, and SSE sectors. The average wind speed was 5.0 mph.

On the other hand, Tables 2 and 3 indicate a predominant upvalley and downvalley flow pattern at both Sites 3 and 4. At Site 3, over 20% of the winds were from the north, while almost 14% were from the south. At Site 4, winds were from the N and NNW sectors almost 32% of the time and from the S or SSE sectors about 16% of the time. The average wind speed during the study period was 2.8 mph at Site 3 and 4.0 mph at Site 4. These comparatively low wind speeds may be attributable to the sheltering effect of the river valley.

At Site 4, there was also a high frequency of winds from the W and WNW sectors. A close inspection of Figure 1 indicates that this is apparently due to the location of a small valley located generally to the west of Site 4. Thus, Site 4 was considered to be somewhat less representative of the upvalley case than Site 3.

Wind direction comparisons (scatter diagrams of concurrent observations) for Site 3 are shown in Table 4 for all observations and in Table 5 for stable (nighttime) observations only. Calm and variable occurrences are indicated separately in the tables. Similarly, wind direction comparisons for Site 4 versus the primary tower are shown in Tables 6 and 7. The following general conclusions can be drawn from a review of Tables 4 and 6 (all observations):

1. When the wind direction is from the SW, SSW, S, and SSE sectors at the primary tower, the wind direction is predominantly upvalley (S to SSE) at Sites 3 and 4.

TABLE 1

WIND FREQUENCY DISTRIBUTION
PRIMARY TOWER

PENN POWER & LIGHT 03/11/82.
PRIMARY TOWER
ONSITE
DAMES AND MOORE JOB NO.- 9999-999-99
DATA PERIOD- 11/11/81 TO 02/17/82
STABILITY CLASS ALL (NO DELTA TEMP)
WINDS AT 10 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	5	35	33	42	16	17	4	3	4	5	0	0	164	3.59
NE	7	46	34	23	10	20	8	8	2	0	0	0	158	3.37
ENE	12	60	17	7	3	2	1	1	1	0	0	0	124	1.96
E	15	62	19	11	6	0	4	3	2	2	1	1	126	2.59
ESE	4	10	4	3	2	3	1	1	2	2	1	1	34	4.07
SE	1	7	1	3	2	2	0	2	0	0	0	0	18	3.34
SSE	3	13	3	2	4	1	1	1	2	3	1	2	36	4.38
S	4	19	7	9	19	7	6	0	1	4	1	4	81	4.45
SSW	2	32	19	14	9	6	6	3	0	0	1	1	93	3.36
SW	4	23	28	24	10	5	7	5	3	0	0	0	109	3.49
WSW	2	18	24	48	39	40	21	16	14	9	8	25	264	5.97
W	2	9	7	22	38	62	45	31	44	34	33	77	404	8.25
WNW	0	4	1	6	9	20	10	10	19	12	11	7	109	7.35
NW	1	4	3	11	17	21	16	12	26	12	19	8	150	7.21
NNW	0	2	4	7	13	14	10	6	10	4	5	4	79	6.50
N	4	23	23	28	20	24	13	9	6	1	2	1	154	4.43
VARIABLE													0	0.
CALM													114	.40
TOTAL	66	387	227	260	217	244	153	111	136	88	83	131	2217	5.02

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN PERCENT OF TOTAL)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	.23	1.58	1.49	1.89	.72	.77	.18	.14	.18	.23	0.	0.	7.40	3.59
NE	.32	2.07	1.53	1.04	.45	.90	.36	.36	.09	0.	0.	0.	7.13	3.37
ENE	.54	3.61	.77	.32	.14	.09	.05	.05	.05	0.	0.	0.	5.59	1.96
E	.68	2.80	.86	.50	.27	0.	.18	.14	.09	.09	.05	.05	5.68	2.59
ESE	.18	.45	.18	.14	.09	.14	.05	.05	.09	.09	.05	.05	1.53	4.07
SE	.05	.32	.05	.14	.09	.09	0.	.09	0.	0.	0.	0.	.81	3.34
SSE	.14	.59	.14	.09	.18	.05	.05	.05	.09	.14	.05	.09	1.62	4.38
S	.18	.86	.32	.41	.86	.32	.27	0.	.05	.18	.05	.18	3.65	4.45
SSW	.09	1.44	.86	.63	.41	.27	.27	.14	0.	0.	.05	.05	4.19	3.36
SW	.18	1.04	1.26	1.08	.45	.23	.32	.23	.14	0.	0.	0.	4.92	3.49
WSW	.09	.81	1.08	2.17	1.76	1.80	.95	.72	.63	.41	.36	1.13	11.91	5.97
W	.09	.41	.32	.99	1.71	2.80	2.03	1.40	1.98	1.53	1.49	3.47	18.22	8.25
WNW	0.	.18	.05	.27	.41	.90	.45	.45	.86	.54	.50	.32	4.92	7.35
NW	.05	.18	.14	.50	.77	.95	.72	.54	1.17	.54	.86	.36	6.77	7.21
NNW	0.	.09	.18	.32	.59	.63	.45	.27	.45	.18	.23	.18	3.56	6.50
N	.18	1.04	1.04	1.26	.90	1.08	.59	.41	.27	.05	.09	.05	6.95	4.43
VARIABLE													0.	0.
CALM													5.14	.40
TOTAL	2.98	17.46	10.24	11.73	9.79	11.01	6.90	5.01	6.13	3.97	3.74	5.91	100.00	5.02

TABLE 2

WIND FREQUENCY DISTRIBUTION
SITE 3

PENN POWER & LIGHT 03/10/82.
SITE3
UPSTREAM
DAMES AND MOORE JOB NO.- 9999-999-99
DATA PERIOD- 11/11/81 TO 02/17/82
STABILITY CLASS ALL (NO DELTA TEMP)
WINDS AT 10 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	7	17	7	2	5	0	0	0	0	0	0	0	38	2.03
NE	2	9	0	1	0	0	0	0	0	0	0	0	12	1.45
ENE	8	6	3	0	0	0	0	0	0	0	0	0	17	1.28
E	10	15	1	0	0	0	0	0	0	0	0	0	26	1.23
ESE	1	5	0	1	0	0	0	0	0	0	0	0	7	1.79
SE	3	11	2	1	0	0	0	0	0	0	0	0	17	1.57
SSE	10	29	24	13	12	1	1	0	0	0	0	0	90	2.48
S	21	33	34	53	27	10	2	2	1	0	0	0	183	3.03
SSW	5	9	10	14	9	3	3	0	0	0	0	0	53	3.20
SW	0	3	3	1	4	3	1	9	8	2	1	0	35	6.37
WSW	0	4	4	6	8	8	0	3	12	7	2	2	56	6.29
W	4	2	5	16	11	11	10	7	7	8	2	1	84	5.65
WNW	2	2	5	8	2	6	4	2	0	0	0	0	31	4.13
NW	1	5	1	4	7	8	2	0	1	0	0	0	29	4.29
NNW	7	18	11	23	21	9	3	0	0	0	0	0	92	3.33
N	23	78	63	47	28	19	6	5	4	1	0	0	274	3.01
VARIABLE													119	1.14
CALM													173	.40
TOTAL	104	246	173	190	134	78	32	28	33	18	5	3	1336	2.82

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN PERCENT OF TOTAL)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	.52	1.27	.52	.15	.37	0.	0.	0.	0.	0.	0.	0.	2.84	2.03
NE	.15	.67	0.	.07	0.	0.	0.	0.	0.	0.	0.	0.	.90	1.45
ENE	.60	.45	.22	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.27	1.28
E	.75	1.12	.07	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.95	1.23
ESE	.07	.37	0.	.07	0.	0.	0.	0.	0.	0.	0.	0.	.52	1.79
SE	.22	.82	.15	.07	0.	0.	0.	0.	0.	0.	0.	0.	1.27	1.57
SSE	.75	2.17	1.80	.97	.90	.07	.07	0.	0.	0.	0.	0.	6.74	2.48
S	1.57	2.47	2.54	3.97	2.02	.75	.15	.15	.07	0.	0.	0.	13.70	3.03
SSW	.37	.67	.75	1.05	.67	.22	.22	0.	0.	0.	0.	0.	3.97	3.20
SW	0.	.22	.22	.07	.30	.22	.07	.67	.60	.15	.07	0.	2.62	6.37
WSW	0.	.30	.30	.45	.60	.60	0.	.22	.90	.52	.15	.15	4.19	6.29
W	.30	.15	.37	1.20	.82	.82	.75	.52	.52	.60	.15	.07	6.29	5.65
WNW	.15	.15	.37	.60	.15	.45	.30	.15	0.	0.	0.	0.	2.32	4.13
NW	.07	.37	.07	.30	.52	.60	.15	0.	.07	0.	0.	0.	2.17	4.29
NNW	.52	1.35	.82	1.72	1.57	.67	.22	0.	0.	0.	0.	0.	6.89	3.33
N	1.72	5.84	4.72	3.52	2.10	1.42	.45	.37	.30	.07	0.	0.	20.51	3.01
VARIABLE													8.91	1.14
CALM													12.95	.40
TOTAL	7.78	18.41	12.95	14.22	10.03	5.84	2.40	2.10	2.47	1.35	.37	.22	100.00	2.82

TABLE 3

WIND FREQUENCY DISTRIBUTION
SITE 4

PENN POWER & LIGHT
SITE4
UPSTREAM
DAMES AND MOORE JOB NO.- 9999-999-99
DATA PERIOD- 11/11/81 TO 02/17/82
STABILITY CLASS ALL (NO DELTA TEMP)
WINDS AT 10 METER LEVEL

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN NUMBER OF OCCURRENCES)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0	1	4	3	0	3	1	3	0	0	0	0	15	4.67
NE	0	1	4	1	0	0	0	0	0	0	0	0	6	2.42
ENE	0	1	1	0	0	0	0	0	0	0	0	0	2	2.05
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
ESE	0	2	0	1	0	0	0	0	0	0	0	0	3	2.53
SE	2	5	5	7	2	1	0	0	0	0	0	0	22	2.76
SSE	6	24	31	22	24	19	10	8	8	1	0	0	153	4.03
S	5	40	37	21	12	15	3	2	0	0	0	0	135	3.03
SSW	1	8	6	5	7	4	1	1	0	0	0	0	33	3.48
SW	1	8	7	5	3	5	4	1	0	0	0	0	34	3.73
WSW	6	10	11	8	7	4	6	4	0	0	0	0	56	3.66
W	27	33	14	24	26	30	18	24	15	7	5	4	227	4.76
WNW	15	52	16	11	17	13	8	7	6	1	0	1	147	3.44
NW	9	33	35	12	9	3	6	3	0	3	2	7	122	3.80
NNW	7	46	44	32	38	33	28	23	19	16	14	49	349	6.20
N	2	16	31	49	40	31	21	12	2	2	3	0	209	4.50
VARIABLE													175	1.10
CALM													63	.39
TOTAL	81	280	246	201	185	161	106	88	50	30	24	61	1751	4.00

WIND FREQUENCY DISTRIBUTION
(FREQUENCY IN PERCENT OF TOTAL)

WIND DIRECTION	UPPER CLASS INTERVALS OF WIND SPEED (MPH) 1	2	3	4	5	6	7	8	9	10	11	>11	TOTAL	MEAN SPEED
NNE	0.	.06	.23	.17	0.	.17	.06	.17	0.	0.	0.	0.	.86	4.63
NE	0.	.06	.23	.06	0.	0.	0.	0.	0.	0.	0.	0.	.34	2.42
ENE	0.	.06	.06	0.	0.	0.	0.	0.	0.	0.	0.	0.	.11	2.05
E	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ESE	0.	.11	0.	.06	0.	0.	0.	0.	0.	0.	0.	0.	.17	2.53
SE	.11	.29	.29	.40	.11	.06	0.	0.	0.	0.	0.	0.	1.26	2.76
SSE	.34	1.37	1.77	1.26	1.37	1.09	.57	.46	.46	.06	0.	0.	8.74	4.03
S	.29	2.28	2.11	1.20	.69	.86	.17	.11	0.	0.	0.	0.	7.71	3.03
SSW	.06	.46	.34	.29	.40	.23	.06	.06	0.	0.	0.	0.	1.88	3.48
SW	.06	.46	.40	.29	.17	.29	.23	.06	0.	0.	0.	0.	1.94	3.73
WSW	.34	.57	.63	.46	.40	.23	.34	.23	0.	0.	0.	0.	3.20	3.66
W	1.54	1.88	.80	1.37	1.48	1.71	1.03	1.37	.86	.40	.29	.23	12.96	4.76
WNW	.86	2.97	.91	.63	.97	.74	.46	.40	.34	.06	0.	.06	8.40	3.44
NW	.51	1.88	2.00	.69	.51	.17	.34	.17	0.	.17	.11	.40	6.97	3.80
NNW	.40	2.63	2.51	1.83	2.17	1.88	1.60	1.31	1.09	.91	.80	2.80	19.93	6.20
N	.11	.91	1.77	2.80	2.28	1.77	1.20	.69	.11	.11	.17	0.	11.94	4.50
VARIABLE													10.01	1.10
CALM													3.60	.39
TOTAL	4.63	15.99	14.05	11.48	10.57	9.19	6.05	5.03	2.86	1.71	1.37	3.48	100.00	4.00

TABLE 4

WIND DIRECTION COMPARISON
ALL OBSERVATIONS
SITE 3 VERSUS PRIMARY TOWER

WIND DIRECTION COMPARISON
SUSQUEHANNA STEAM ELECTRIC STATION
DATA PERIOD- DEC1681 TO FEB1782
FREQUENCY IN NUMBER OF OCCURRENCES
WINDS AT 10 METER LEVEL

PRIMARY TOWER — SITE3

SECTOR	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	VARI	TOTAL
NNE	7	5	4	0	0	0	0	1	0	0	0	1	1	1	12	51	5	9	97
NE	6	3	2	6	0	0	5	0	1	0	0	0	0	0	9	48	18	9	107
ENE	6	0	1	3	0	0	1	2	0	0	0	0	0	0	4	21	25	15	78
E	3	0	3	1	1	0	1	9	2	0	0	1	0	1	2	10	19	12	65
ESE	1	0	0	0	0	0	3	3	0	0	0	1	0	0	2	5	3	4	22
SE	0	0	0	0	0	1	2	7	0	0	0	0	0	0	1	1	1	2	15
SSE	0	0	0	0	0	2	8	10	2	0	0	0	0	0	0	2	1	3	28
S	1	0	1	1	1	4	17	22	1	0	1	0	1	1	1	3	4	5	64
SSW	0	0	0	1	1	2	12	31	5	0	0	0	0	0	1	3	9	10	75
SW	0	0	1	0	1	2	13	35	6	1	0	1	0	1	0	1	7	9	78
WSW	0	0	1	1	1	2	18	33	23	20	19	11	4	0	0	3	9	8	153
W	1	0	0	3	2	0	4	13	9	11	29	50	9	11	2	6	11	6	167
WNW	0	0	0	0	0	1	1	2	0	0	0	7	9	9	18	3	3	2	55
NW	2	0	1	1	0	0	3	0	1	1	0	0	1	2	18	15	0	2	47
NNW	2	0	0	3	0	1	0	0	0	0	0	0	1	0	8	18	1	2	36
N	4	4	1	2	0	0	0	0	0	1	0	0	0	0	5	50	6	9	82
CALM	0	0	1	2	0	0	0	4	0	0	0	0	0	2	8	4	28	4	53
VARI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	33	12	16	24	7	15	88	172	50	34	49	72	26	28	91	244	150	111	1222

NUMBER OF INVALID OBSERVATIONS= 284

TABLE 5

WIND DIRECTION COMPARISON
NIGHTTIME OBSERVATIONS
SITE 3 VERSUS PRIMARY TOWER

WIND DIRECTION COMPARISON
SUSQUEHANNA STEAM ELECTRIC STATION
DATA PERIOD- DEC1681 TO FEB1782
FREQUENCY IN NUMBER OF OCCURRENCES
WINDS AT 10 METER LEVEL

PRIMARY TOWER — SITE3

SECTOR	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	VARI	TOTAL
NNE	6	5	4	0	0	0	0	1	0	0	0	0	0	0	2	25	4	7	54
NE	4	3	2	6	0	0	4	0	0	0	0	0	0	0	4	23	17	7	70
ENE	6	0	1	2	0	0	0	2	0	0	0	0	0	0	1	17	24	14	67
E	3	0	3	1	1	0	1	5	2	0	0	0	0	0	1	7	19	10	53
ESE	1	0	0	0	0	0	2	3	0	0	0	0	0	0	1	5	2	2	16
SE	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	1	1	1	7
SSE	0	0	0	0	0	1	3	4	1	0	0	0	0	0	0	1	0	3	13
S	0	0	0	0	0	1	3	2	0	0	1	0	1	1	1	2	4	2	18
SSW	0	0	0	0	0	1	4	7	1	0	0	0	0	0	0	3	5	5	26
SW	0	0	0	0	0	0	5	5	0	1	0	0	0	0	0	0	5	3	19
WSW	0	0	1	0	1	1	8	0	1	1	1	0	0	0	0	0	6	6	26
W	1	0	0	1	2	0	1	2	3	1	2	9	0	1	1	4	8	3	39
WNW	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	1	3	0	7
NW	1	0	1	1	0	0	3	0	0	0	0	0	1	1	4	5	0	1	18
NNW	1	0	0	3	0	1	0	0	0	0	0	0	0	0	1	8	1	2	17
N	4	2	1	2	0	0	0	0	0	1	0	0	0	0	0	23	3	7	43
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	25	2	32
VARI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	27	10	13	16	4	6	34	35	8	4	4	11	2	4	18	127	127	75	525

NUMBER OF INVALID OBSERVATIONS= 95

TABLE 6

WIND DIRECTION COMPARISON
ALL OBSERVATIONS
SITE 4 VERSUS PRIMARY TOWER

WIND DIRECTION COMPARISON
SUSQUEHANNA STEAM ELECTRIC STATION
DATA PERIOD- NOV1181 TO FEB1782
FREQUENCY IN NUMBER OF OCCURRENCES
WINDS AT 10 METER LEVEL

PRIMARY TOWER — SITE4

SECTOR	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	VARI	TOTAL
NNE	5	0	0	0	0	0	1	3	0	0	0	4	7	8	51	45	1	7	132
NE	4	5	1	0	0	0	0	7	1	0	0	4	8	10	24	46	3	17	130
ENE	1	1	0	0	0	0	3	7	0	0	0	11	14	3	15	11	6	25	97
E	0	0	0	0	1	0	7	8	1	0	0	13	11	7	17	14	7	15	101
ESE	0	0	0	0	0	1	8	5	0	0	0	0	0	3	5	1	4	3	30
SE	0	0	0	0	0	0	7	0	1	1	1	0	0	0	3	1	0	1	15
SSE	0	0	0	0	1	0	10	10	0	1	1	0	0	0	2	0	1	6	32
S	0	0	0	0	0	1	24	16	4	0	0	3	2	7	3	1	1	3	65
SSW	0	0	0	0	0	3	21	13	1	2	0	1	4	4	1	1	4	9	64
SW	0	0	0	0	0	9	14	17	5	2	1	7	2	0	2	1	7	15	82
WSW	0	0	0	0	0	4	28	27	18	15	15	26	9	4	2	1	5	21	175
W	0	0	1	0	0	0	7	8	2	12	34	118	49	12	13	5	1	12	274
WNW	0	0	0	0	0	1	2	1	0	0	0	16	15	17	23	1	0	3	79
NW	0	0	0	0	0	0	1	1	0	0	0	2	8	12	84	6	0	3	117
NNW	0	0	0	0	1	0	0	0	0	0	0	0	1	7	37	11	0	3	60
N	3	0	0	0	0	0	0	4	0	0	0	2	6	13	49	42	0	3	122
CALM	0	0	0	0	0	0	9	5	1	0	0	2	2	4	6	5	10	16	60
VARI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13	6	2	0	3	19	142	132	34	33	52	209	138	111	337	192	50	162	1635

NUMBER OF INVALID OBSERVATIONS= 715

TABLE 7

WIND DIRECTION COMPARISON
NIGHTTIME OBSERVATIONS
SITE 4 VERSUS PRIMARY TOWER

WIND DIRECTION COMPARISON
SUSQUEHANNA STEAM ELECTRIC STATION
DATA PERIOD- NOV1181 TO FEB1782
FREQUENCY IN NUMBER OF OCCURRENCES
WINDS AT 10 METER LEVEL

PRIMARY TOWER — SITE4

SECTOR	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	VARI	TOTAL
NNE	1	0	0	0	0	0	0	2	0	0	0	3	6	8	30	15	1	7	73
NE	2	1	0	0	0	0	0	6	1	0	0	4	8	10	18	13	2	15	80
ENE	1	0	0	0	0	0	2	6	0	0	0	10	14	3	12	9	6	25	88
E	0	0	0	0	0	0	5	6	1	0	0	13	11	6	11	8	7	15	83
ESE	0	0	0	0	0	1	5	4	0	0	0	0	0	3	3	0	3	2	21
SE	0	0	0	0	0	0	2	0	0	1	0	0	0	0	2	0	0	1	6
SSE	0	0	0	0	0	0	4	6	0	0	0	0	0	0	2	0	0	4	16
S	0	0	0	0	0	0	1	2	1	0	0	2	2	6	2	0	1	2	19
SSW	0	0	0	0	0	0	9	5	0	0	0	0	1	3	0	0	1	6	25
SW	0	0	0	0	0	3	3	1	0	0	0	1	0	0	0	1	4	8	21
WSW	0	0	0	0	0	1	8	7	0	3	1	1	0	0	0	0	2	6	29
W	0	0	0	0	0	0	2	2	0	0	1	4	7	3	4	3	1	3	30
WNW	0	0	0	0	0	0	1	0	0	0	0	1	2	2	5	0	0	1	12
NW	0	0	0	0	0	0	1	1	0	0	0	1	5	3	10	0	0	2	23
NNW	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	1	0	3	12
N	0	0	0	0	0	0	0	4	0	0	0	1	6	11	27	9	0	3	61
CALM	0	0	0	0	0	0	7	3	0	0	0	2	2	4	3	5	9	16	51
VARI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4	1	0	0	0	5	50	55	3	4	2	43	65	63	135	64	37	119	650

NUMBER OF INVALID OBSERVATIONS= 237

2. When the wind direction is from the NNW, N, NNE, NE, AND ENE sectors at the primary tower, the wind direction is primarily downvalley (N) at Site 3. Similarly, downvalley flow (N to NNW) occurs at Site 4 when the wind direction is NNW, N, NNE, NE, ENE, or E at the primary tower, although an anomalous local flow (W, WNW, and NW primarily) also occurs. This anomalous flow is probably attributable to the effects of the valley located generally west of Site 4.

3. There is also a shift to upvalley flow (SSE and S) at both Sites 3 and 4 when the wind direction is WSW at the primary tower, but this does not occur as frequently as the shift noted in 1. above.

4. When the wind direction is from the west at the primary tower, a high frequency of winds are also westerly at Sites 3 and 4, but there is also a lot of variability in wind direction at Site 3 and 4.

The same general features are observed during stable (nighttime) conditions (Tables 5 and 7) with one notable exception; for WSW flow at the primary tower, the flow is primarily upvalley at Sites 3 and 4.

Relating the results of the comparative analysis above to the Dames & Moore subjective model indicates that the basic assumption of a shift to upvalley flow (S to SSE) for SW, SSW, and S wind directions at the primary tower is substantiated. In addition, the results indicate that a large percentage of WSW winds at the primary tower also shift to upvalley flow and that this shift is most pronounced during nighttime hours.

The subjective model assumption that the shift to upvalley flow occurs only during light wind speeds of less than 2 m/sec and stable atmospheric conditions does not appear to be appropriate except perhaps for WSW flow. The development of more specific scatter diagrams was made to further investigate the wind speed and stability restrictions of the subjective

model. Applicable scatter diagrams are presented in Appendix A and indicate the following:

1. Comparison of Case 1 and 2 indicates little dependence of the shift to upvalley flow (S to SSE) at Sites 3 and 4 on low wind speeds and stable (nighttime) conditions. However, a good wind direction correlation was indicated for those few observations where the wind speed was 9 mph or greater at the primary tower. This suggests that the wind speed restriction should be revised from 2 m/sec to perhaps 4 m/sec (9 mph).

2. Case 3, which was included to investigate the apparent localized shift to westerly flow at Site 4 (not observed at Site 3), indicates that the shift occurs primarily when the wind flow is NNE to E and the wind speed is less than 5 mph at the primary tower.

3. Case 4 indicates a frequent shift to upvalley flow at Sites 3 and 4 also occurs for WSW flow at the primary tower, but is restricted primarily to hourly observations when the average wind speed is less than 5 mph at the primary tower.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The scatter diagrams for all observations shown in Case 2 of Appendix A indicate that, for the upvalley case (winds from the SW, SSW, and S at the primary tower), the stability class restriction should be removed from the subjective model and the wind speed restriction should be changed to 4 m/sec (9 mph) or less. Also, the analysis indicates that WSW winds should be included in this case, at least during conditions with wind speeds less than 5 mph. Winds from the west at the primary tower correlated fairly well at Sites 3 and 4, although there was a lot of variability which may be due to the transitional effects of upvalley to downvalley flow patterns in the river valley.

Since the results of the computer analysis suggested modifications to the subjective model, consideration should be given to locating a supplemental tower upvalley of the SSES. This tower would be useful to confirm that the plume is going upvalley as predicted, particularly since there are certain flow cases at the primary tower (for example, WSW winds) that cannot be adequately represented by the subjective model.

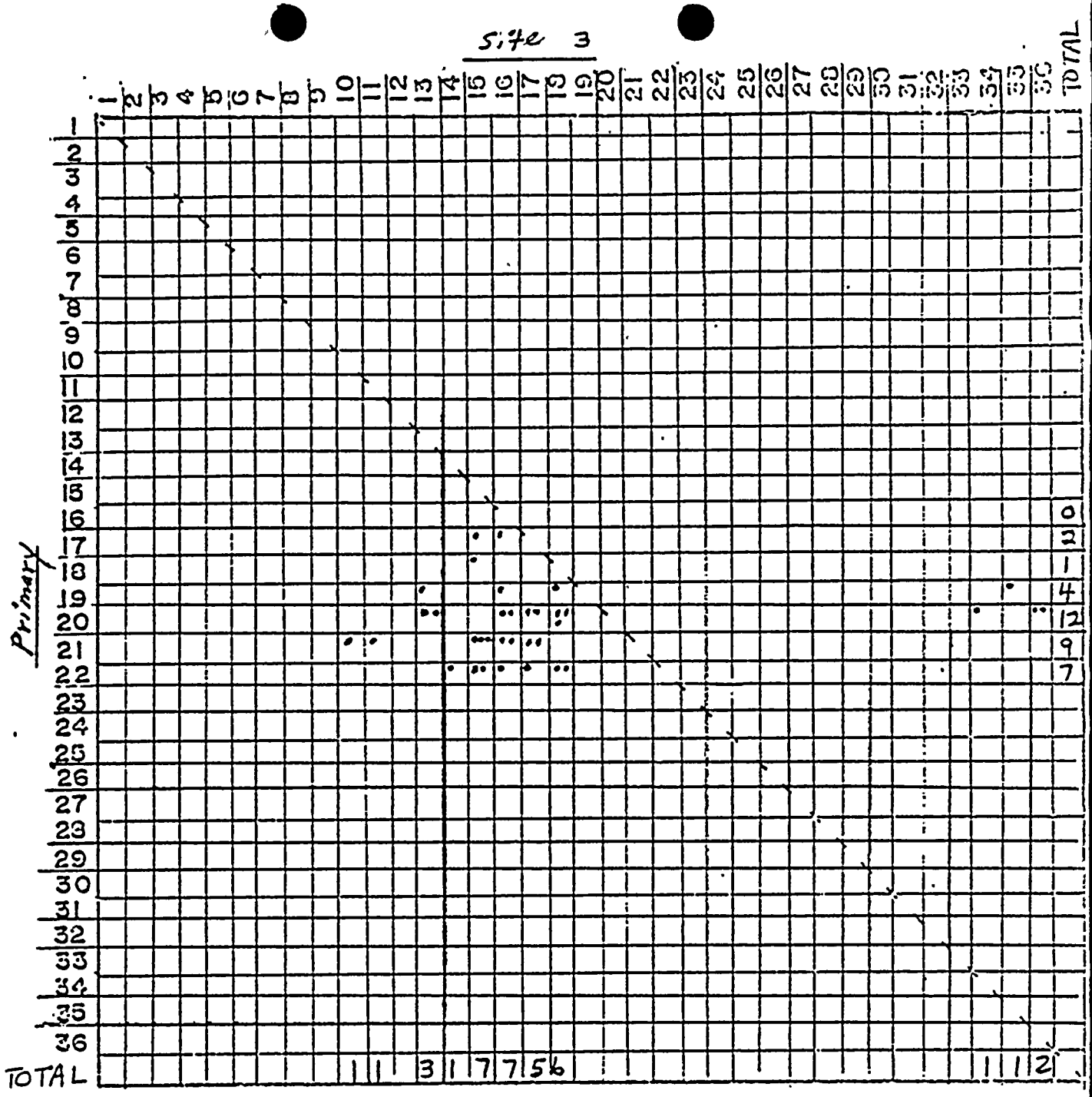
The preferred upvalley supplemental tower location would be in the vicinity of Site 3 since the occasional shift to westerly flow at Site 4 (when not observed at Site 3) is believed to be an anomalous local flow that is not representative of the general upvalley flow regime.

One other point should be made. Although the upvalley flow beyond the bend in the Susquehanna River at Shickshinny was not evaluated in this study, the evidence of a shift to upvalley flow at Sites 3 and 4 indicate that a plume entering the river valley is likely to remain in the river valley beyond this bend.

APPENDIX A

SCATTER DIAGRAMS

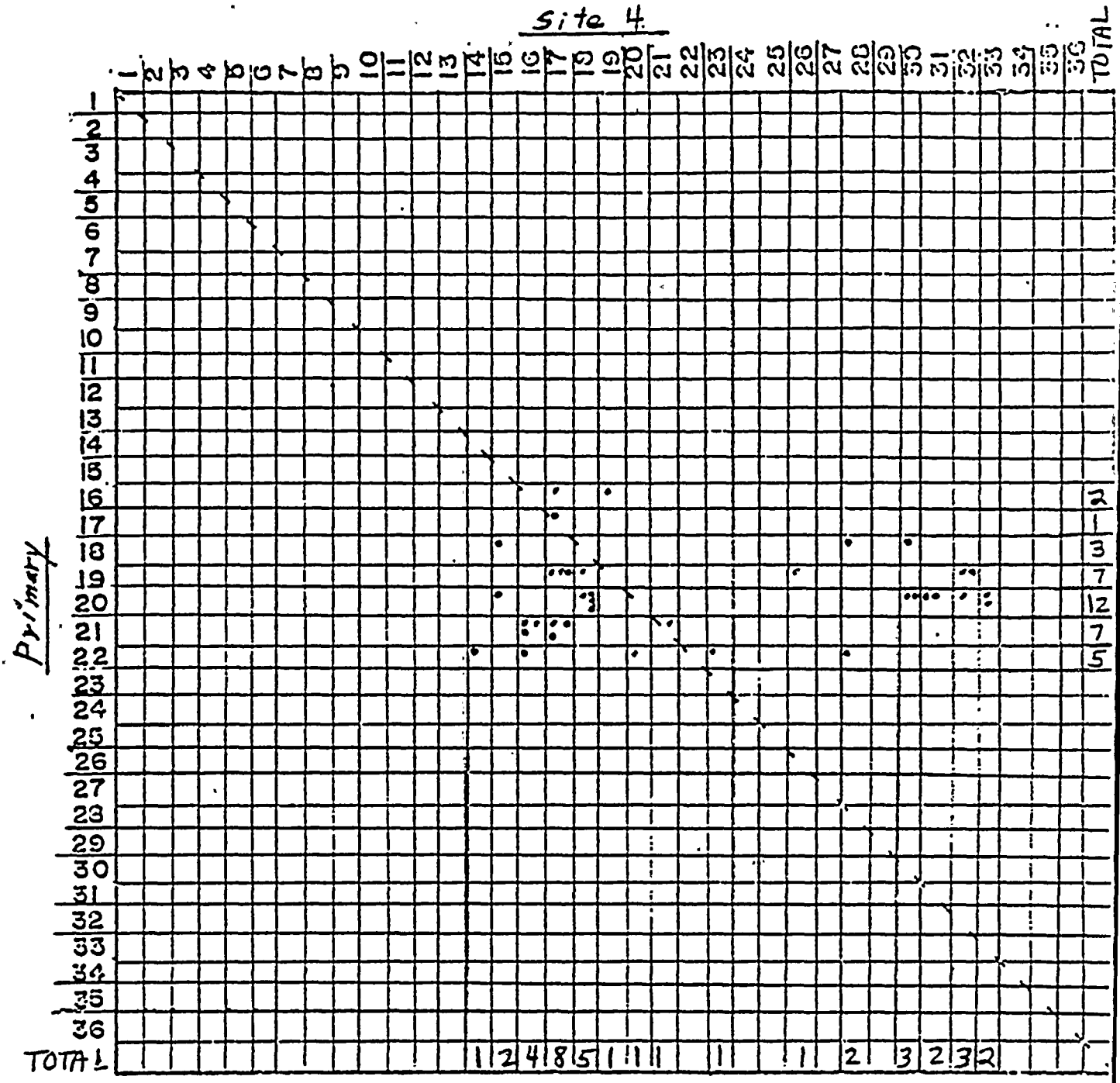
Site 3



CASE 1

Description: WD at primary tower restricted to 160-220.
WS at " " " to ≤ 4.5 mph.
Hours restricted to nighttime (1800-0700).

Results: Only 35 occurrences, but 25 (71%) were from 150-180 at Site 3.



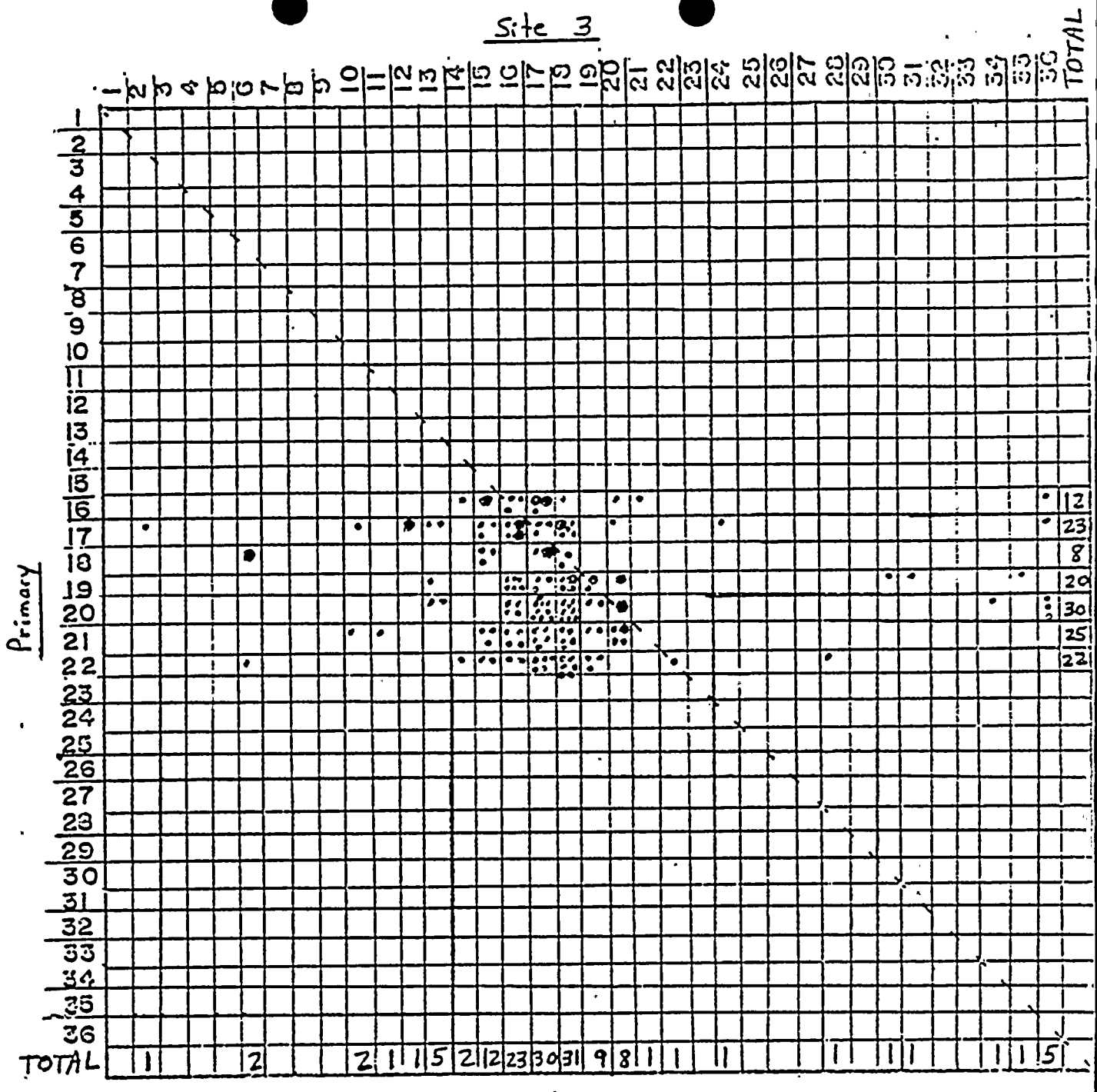
CASE 1

Description: WD at primary tower restricted to 160-220.
WS at " " " to ≤ 4 mph.
Hours restricted to Nighttime (1800-0700).

Results: Only 37 occurrences. 19 (51%) were from 150-180 at Site 4; another 10 were from 300-330.

CHECKED BY _____ DATE _____ FILE _____ BY _____ DATE _____

Site 3

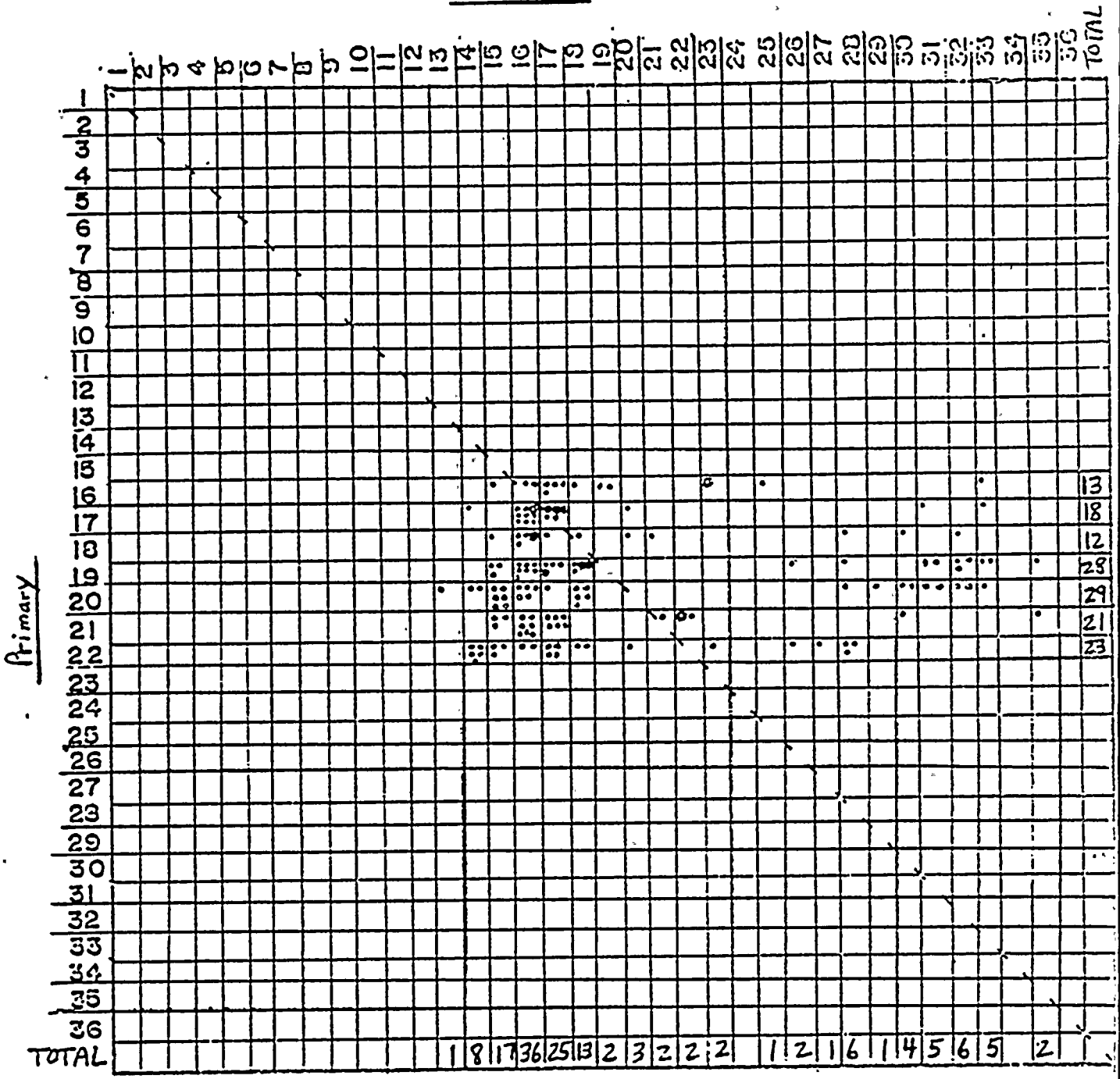


CASE 2

Description: WD at primay tower restricted to 160-220.

Results: 140 occurrences. 96(69%) were from 150-180 at Site 3; another 17 were from 190-200; of the 61 occurrences from 170-180 at Site 3, 30 occured at night. Circled points were for WS ≥ 9mph at primary tower and indicates good correlation at these WS.

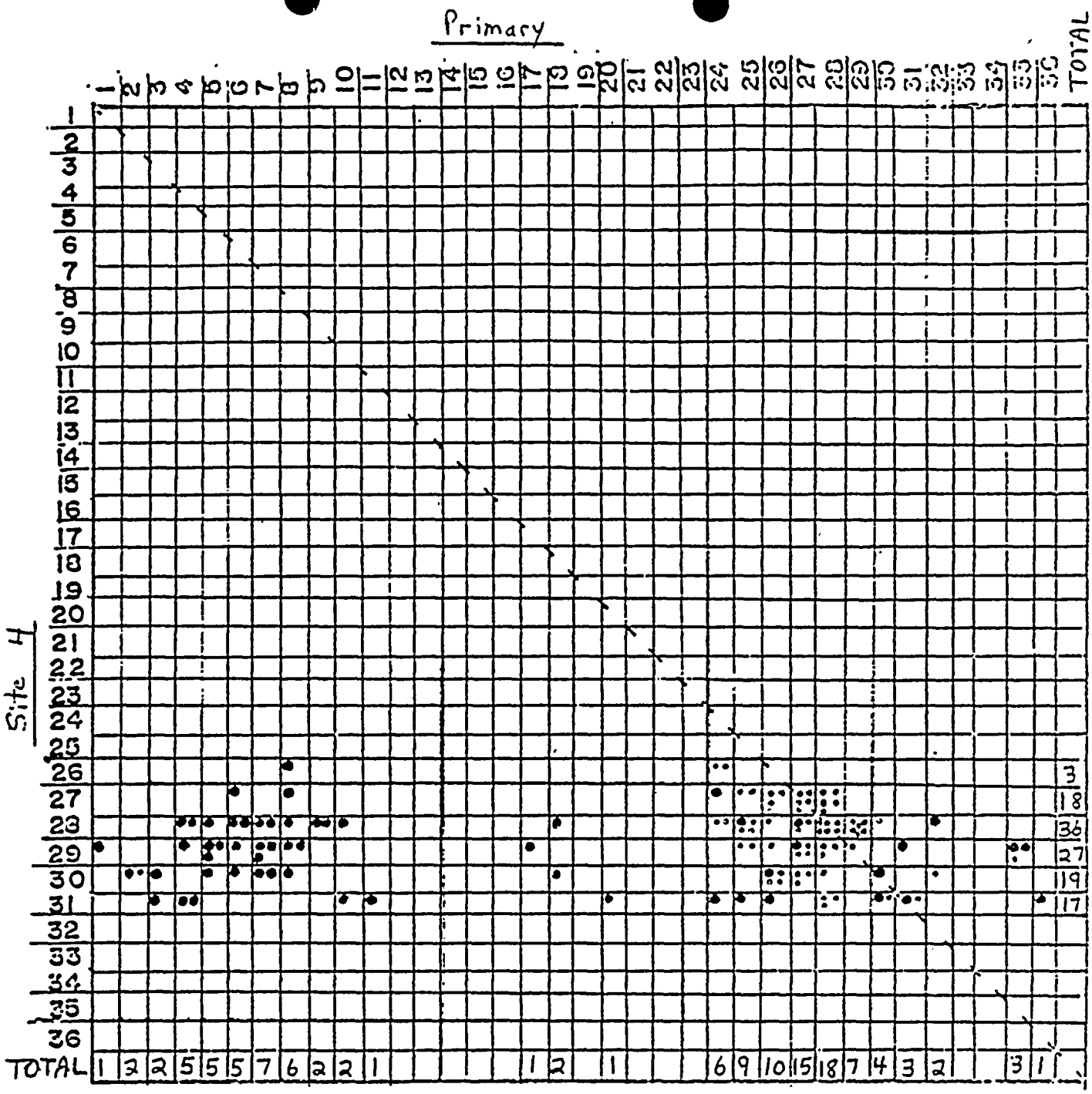
Site 4



CASE 2

Description: WD at primary tower restricted to 160-220.

Results: 144 occurrences. 91 (63%) were from 150-180 at Site 4; another 8 from 140; of the 61 occurrences from 160-170 at Site 4, only 18 occurred at night. There were also 27 from 280-330 at Site 4. (Circled points were for WS ≥ 9 mph at primary tower.)



CASE 3

Description: WD at Site 4 restricted to 260-310.
(Circled points indicates ws < 5 mph at primary tower)

Results: 383 occurrences (Only 1st 60 and last 60 plotted).
Indicates shift to westerly flow at Site 4 occurs primarily for easterly flow and ws < 5 mph at primary tower.

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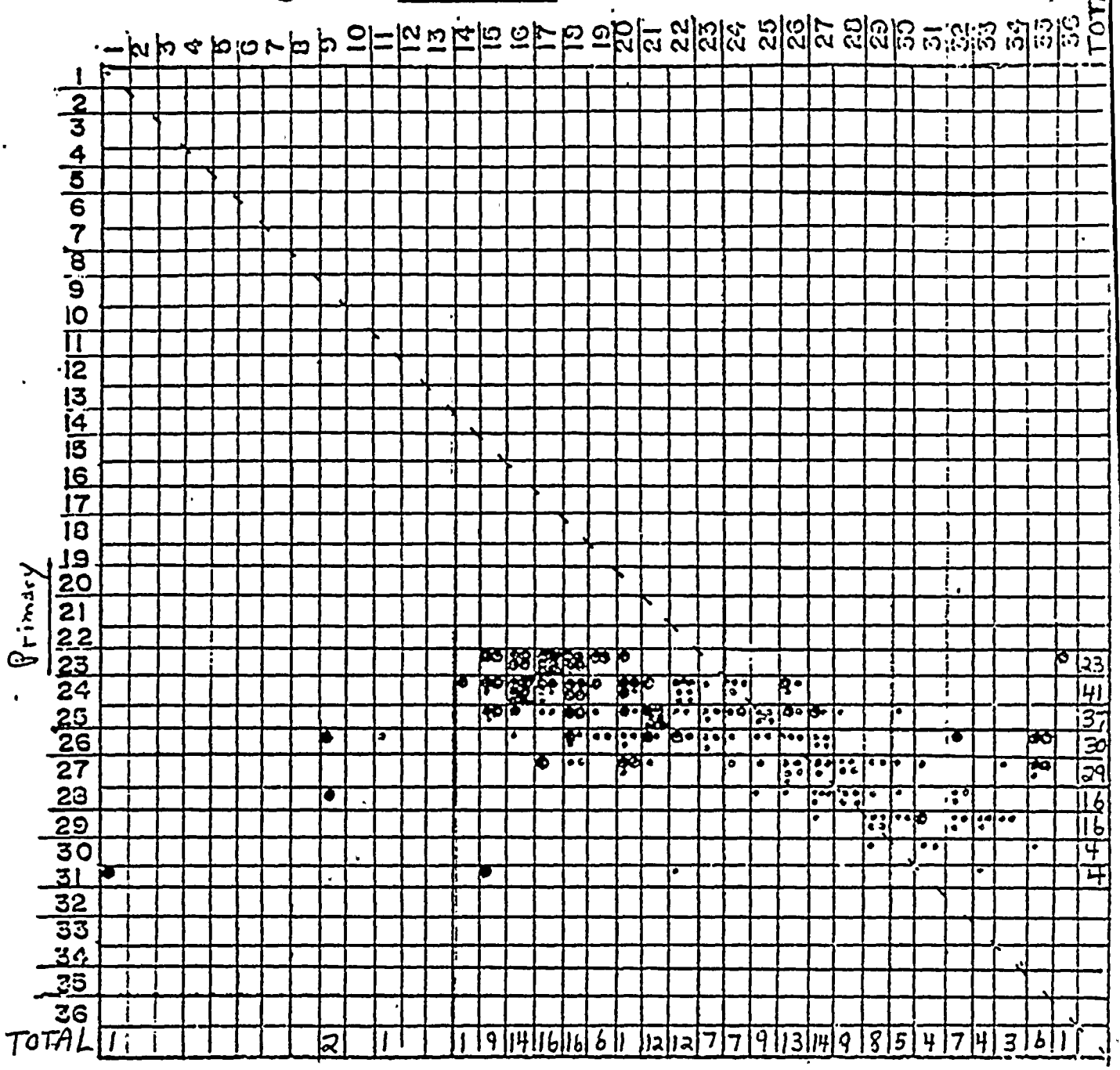
Site 3



CASE 4

Description: WD at primary tower restricted to 230-310.
(Circled points indicates WS < 5 mph at primary tower.)

Results: 399 occurrences (Only 1st 100 and last 100 plotted).

WD 230 at PT: Generally 150-180 at Site 3.
WD 240-250 at PT: 150-200 at ST3 during light winds.
WD 260 at PT.: WD scattered at Site 3.
WD 270-290 at PT: Good correlation at Site 3.
WD 300-310 at PT: Few occurrences.