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A COMPARISON OF THE PERCENTAGE FREQUENCY OCCURRENCE OF GROUND BASED INVERSIONS AT PRINCE GEORGE

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INTRODUCTION

Inversions are a significant factor in determining the extend and degree of vertical dispersion, and indirectly the horizontal dispersion, of emitted pollutants. In British Columbia, the referral system for processing Pollution Control Permit applications from industry has the original application going to the provincial Pollution Control Branch, with subsequent referral to the Environmental Protection Service (Federal) and then to the Atmospheric Environment Service. The A.E.S. is responsible for meteorological analysis and input of localized parameters affecting emission dispersion and therefore air quality. Part of the meteorological input is an estimation of the percentage frequency occurrence of ground based inversions per season at the two times of day corresponding to Radiosonde release.

PROCEDURE

The resulting percentages of inversion frequency for the various locals are determined from a consideration of:

1) A STUDY BY MUNN, TOMLAIN & TITUS OF "THE FREQUENCY OF GROUND BASED INVERSIONS IN CANADA".

This particular study was based on a limited data base (July, 1965 to June, 1968) using radiosonde ascent data from the Canadian network of Upper Air Stations. In order to aid in placing the isopleths, values of occurrence for U.S. Stations just south of the border were added.

The definition of an inversion occurrence was based on temperatures at the surface compared against temperatures at the first significant level of the ascent. Data recorded within the first 10 mb (90 metres) was not considered because of the unreliability of recorded data immediately off the surface. Therefore a radiosonde defined ground based inversion occurs only when the air temperature at the first significant level above 90 metres is warmer than or equal to the surface air temperature. That is, isothermal conditions also count as an inversion occurence. Isopleths of equal value (percentages) were then drawn per season corresponding to the early morning and late afternoon release. Seasons were defined at winter - December, January and February and so on. In drawing the isopleths there was no consideration of local effects enhancing or detracting from inversion set ups, though in most cases these factors and subsequent effects are built in.

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2) A STUDY BY EMSLIE (A.E.S.) OF "GROUND BASED INVERSION FREQUENCIES DETERMINED FROM SURFACE CLIMATOLOGICAL DATA IN B.C."

This study compared long term official climatological maximum and minimum data recorded at 35 pairs of valley/ridge climatological stations in B.C., with at least several years of coincident data. Isothermal conditions were not considered an event.

3) A subjective input to the percentage occurrences implying a consideration of local topographic effects, was the final input.

Such effects are due to a) the mountains and valleys leading to drainage winds - valley winds and b) to bodies of water establishing sea/land breezes plus c) the heat island effect in the larger urban areas. These factors must be considered in determining inversion frequencies for the specific sites.

For the Prince George area, by using the Munn e al study, the following inversion frequencies per season at the two release times are arrived at:

	WINTER	SPRING	SUMMER	FALL
PM	28	5	5	12
AM	53	60	75	62

The Emslie study of percentages for the Prince George Airport versus Prince George Foreman Flats based on 4½ years data came out as follows:

	WINTER	SPRING	SUMMER	FALL
PM	46	23	22	38
AM	63	73	67	61

Beginning in August, 1976 the Prince George Weather Office has been abstracting specific data daily from the local radiosonde ascents and forwarding the data monthly to Scientific Services in Pacific Region. For the period through September, 1981, this has meant a data base of 3712 cases. Surface base inversions and tops, in mbs., has been one item regularily abstracted.

As a further check of the above two studies and of the results for the Prince George area, the data for the 5 year and period August 1976 to September 1981 was analyzed for the frequency of ground based inversions by month. In this case isothermal occurrences were not considered as an event.

RESULTS

Results were as follows:

	WINTER	SPRING	SUMMER	FALL
PM	47	2	1	15
AM	67	65	75	68

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In order to better compare the results the data was reorganized as follows:

DATA PERIOD		MUNN 7/65-6/68	EMSLIE 3/62-10/66	CURRENT 8/76-9/81
Winter	PM	28	46	47
	AM	53	63	67
Spring	PM	5	23	2
	AM	60	73	65
Summer	PM	5	22	1
	AM	75	67	75
Fall	PM	12	38	15
	AM	62	61	68

As is evident the morning values in all 3 cases compare very well. The afternoon (PM) values for Spring, Summer and Fall in the current analysis compare to the Munn study (also based directly on the Radiosonde run from the Airport), but are significantly less than values determined in the Emslie two station study. A possible and likely reason for this fact may be that the lower elevation station - Foreman Flats - to which the Prince George Airport daily maximum and minimum temperatures was compared is 4.7 km due north - map attached. Foreman Flats is bounded by the Fraser River on the immediate south, east and north and opening to land only to the northwest. The river varies in width from 1/5 km to 2/5 km the area of Foreman Flats has heavy industry including two pulp mills and one oil refinery. Considering the characteristics of the area then i.e. the Fraser River as a source of some cooling plus the heat island effect of the industry, it is quite likely that a minor sea breeze sets up in late spring, summer and early fall such that temperature maximums are lower than at the airport, allowing the formation of a shallow inversion at the site, or at least giving the impression of an inversion relative to the higher (elevation) airport temperature. This results in the higher percentage figures in spring, summer and fall afternoons. A logical concern in this area then becomes the vertical transport of local emissions in the area and time period when this is normally excellent. The logical step may be a possible requirement for higher stacks, if there is evidence of localized concentrations.

The current abstracted data for the airport also includes the inversion tops in mbs. For interest only these were averaged for both time periods per season with the following results:

	WINTER	SPRING	SUMMER	FALL
PM	873 mb	891	919	877
AM	868	903	901	890

It should be noted that afternoon occurrences in summer were minimal, as would be expected, with only few inversion occurrences reported. The deeper inversions are very evident in winter due to the frequent periods

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with arctic air covering the B.C. interior. Through the period analyzed the absolute lowest and highest depth observed of ground based inversions was as follows:

	Minimum	Maximum
AM	SFC - 942	SFC - 651
PM	SFC - 950	SFC - 692

CONCLUSIONS

In conclusion then, this particular exercise confirms the importance of the detailed local consideration of factors with each permit application in B.C. This also confirms the influence of the many local weather variations and their influence on site inversions.

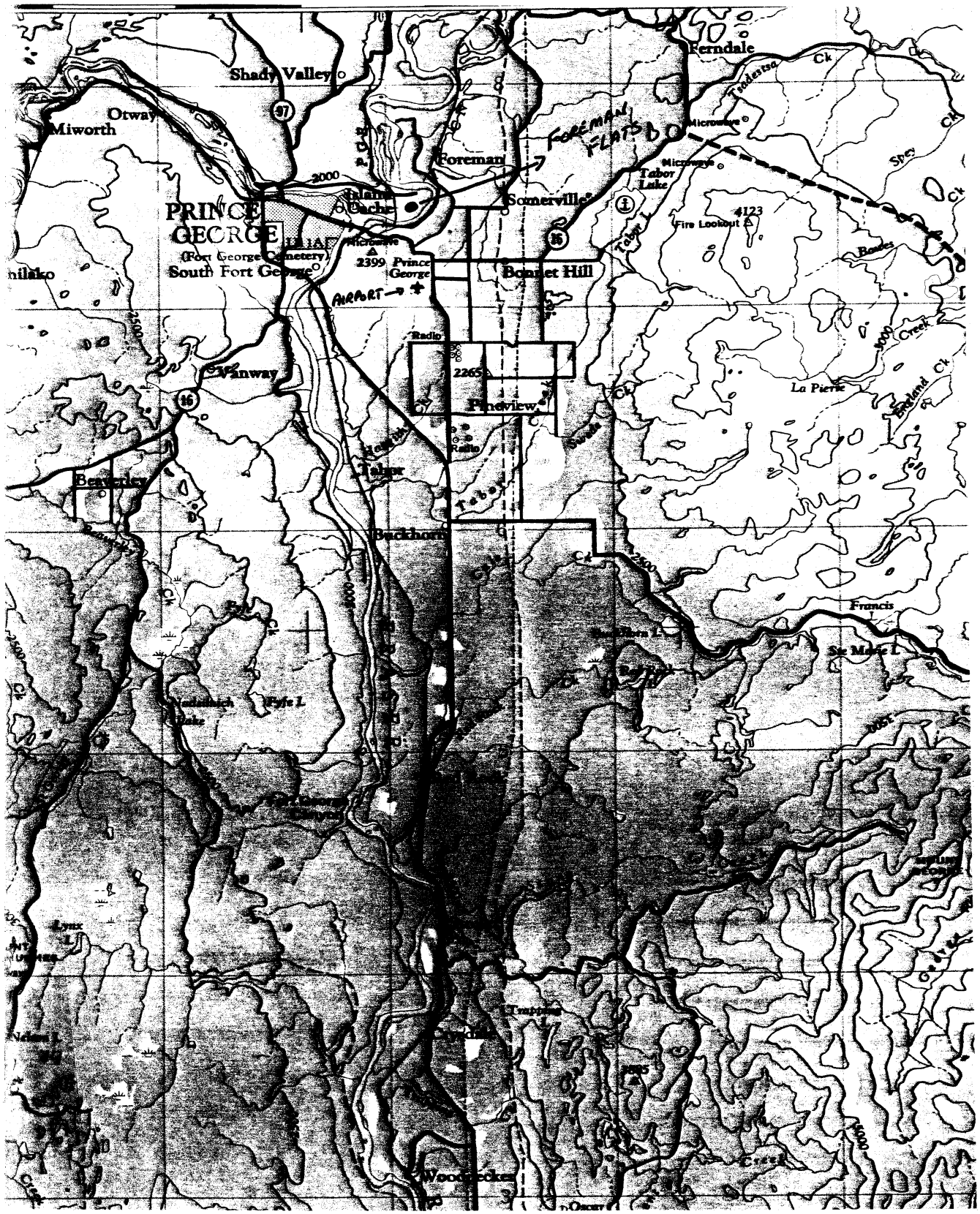

Figure No 1. Regional Map showing the Relative locations of Foreman Flats with respect to Prince George and Prince George airport.