UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

REPORT ON CLIMATE, AIR QUALITY, AND NOISE FOR THE CACHE CREEK-BEAR THRUST ENVIRONMENTAL IMPACT STATEMENT

By Paul W. Kruger

Open-File Report 81-859

Billings, Montana
June 1981

CONTENTS

ILLUSTRATIONS

TABLES

SUMMARY

Impacts to the climate from drilling operations discussed in the Cache Creek-Bear Thrust Environmental Impact Study area would not be measurable; however, climatic factors must be considered in planning the proposed operations. These considerations include the placement of roads for ease of maintenance, the pumping dry of reserve pits for adequate drying, and conducting helicopter operations in the proper or safest seasons.

Impacts to the air quality of the area from exploratory drilling operations would be minimal and temporary. Drilling engine exhaust and dust pollutants would be at a maximum only during the 6-month drilling season and would return to predrilling levels after the abandonment or completion of the proposed test wells. Field development could multiply these impacts to a degree of significance that cannot be determined at this time. We can, however, speculate reasonably that the establishment of a gas processing and/or sweetening plant in the Jackson Hole Area would have significant, long-term impacts to the air quality of the area, with potential degradation to nearby Class I attainment areas (Miller and others, 1980, p. VII-1).

The risk, although minimal, does exist for a hydrogen sulfide (H_2S) blowout/breakout at both National Cooperative Refinery Association (NCRA) and Getty Oil Company (Getty) proposed wellsites. Under worst possible meteorological conditions, and in an extreme H_2S blowout case, H_2S concentrations could build up to a point (15 ppm) that throat and eye irritation could result in Jackson (R. Fisher, written communication, 1980). Current procedures to monitor and control during drilling H_2S coupled with requirements for blowout prevention equipment would reduce this risk considerably.

In the event of field development special problems would exist within the Cache Creek drainage for air quality with the potential for small concentrations of hydrocarbon odors (or in the event of sour gas development, H_2S) to move down canyon to the town of Jackson. Odors related to field development within the Cache Creek Canyon would be most noticeable to recreationists in the canyon.

Field development of the Little Granite Creek area poses only moderate air quality problems as future wellsites would probably be located on high ridges or bench areas. These sites would have a good potential to disperse pollutants.

Noise impacts from a single exploratory well and access road could result in a ¼- to ½-mile influence zone around the drilling rig and access road. These noise levels would tend to drive wildlife from these influence zones in all but food-stress situations. For a single well, this impact is not significant; however, the effects of numerous wellsites and access roads would result in overlapping influence zones that would drive wildlife to other areas of less development. If an entire habitat were to be developed, wildlife populations might decline; to what degree cannot be determined (U.S. Geological Survey Open-File Report 81-851).

Noise impacts from a drilling well would be temporary. Access and noise levels would be at their peak during the drilling phase, but would decrease considerably after drilling.

Use of residential streets in Jackson, Wyoming, for access to the Cache Creek site would result in extensive day and night (sleep) interference to the residents of the town, and such use is not recommended.

INTRODUCTION

The report was written as a supplement for the Cache Creek-Bear Thrust Environmental Impact Statement (EIS). The EIS addresses the impacts of two proposed drilling operations in the vicinity of Jackson, Wyoming (fig. 1). The EIS briefly discusses the potential impacts of field development if hydrocarbons are found in commercial quantities.

This report presents a general description of the climate in the study area, a discussion of potential impacts of exploratory operations and field development on air quality, and a discussion of noise impacts related to these operations.

Baseline data concerning the area is presented with a quantitive discussion of the magnitude of impacts. Qualitative conclusions are described and incorporated into potential mitigating measures.

ACKNOWLEDGMENTS

The author wishes to extend his appreciation to the Environmental Protection Agency, Region 8, especially Dennis Sohocki, Larry Svoboda, Randolph Reeder, John Dale, and Richard Fisher for having provided technical guidance and support for this report. Also, special acknowledgments are extended to Gordon Everett of Everett and Associates, the Environmental Affairs Staff of General Motors, and the numerous oil and gas representatives for providing background information used in preparation of this report.

GLOSSARY

AVERAGE SOUND LEVEL.--A sound level typical of the sound levels at a certain place in a stated time period. Technically, average sound level in decibels is a mean-square A-weighted sound pressure level over the stated time period, unless some other frequency weighting is specified. Average sound level differs from sound level in that average sound level equal gives equal emphasis to all sounds within the stated averaging period, whereas sound level is an exponential time-weighting which puts much more emphasis on sounds existing at the moment of measurement.

EQUIVALENT CONTINUOUS SOUND LEVEL (L_{eq}).--The same as average sound level. The pertinent time period during which the energy averaging is made must be stated. L_{eq} (x) represents the average energy content in dBA of a fluctuating noise source over a specified period of time, such as 8 or 24 hours. The subscript (x) represents the period in which the energy is computed and measured. Current practice references the quantity to either one hour, 8 hours, or 24 hours. L_{eq} is also sometimes called HNL (Hourly Noise Level) when referenced to one hour. When L_{eq} contains no reference to the period, it is understood to mean 24 hours. Since L_{eq} is the summation of the functional products of noise level and duration, many combinations of noise level, duration time, and time history can make up the same L_{eq} value. Thus, an L_{eq}(24) which equals 50 means only that the

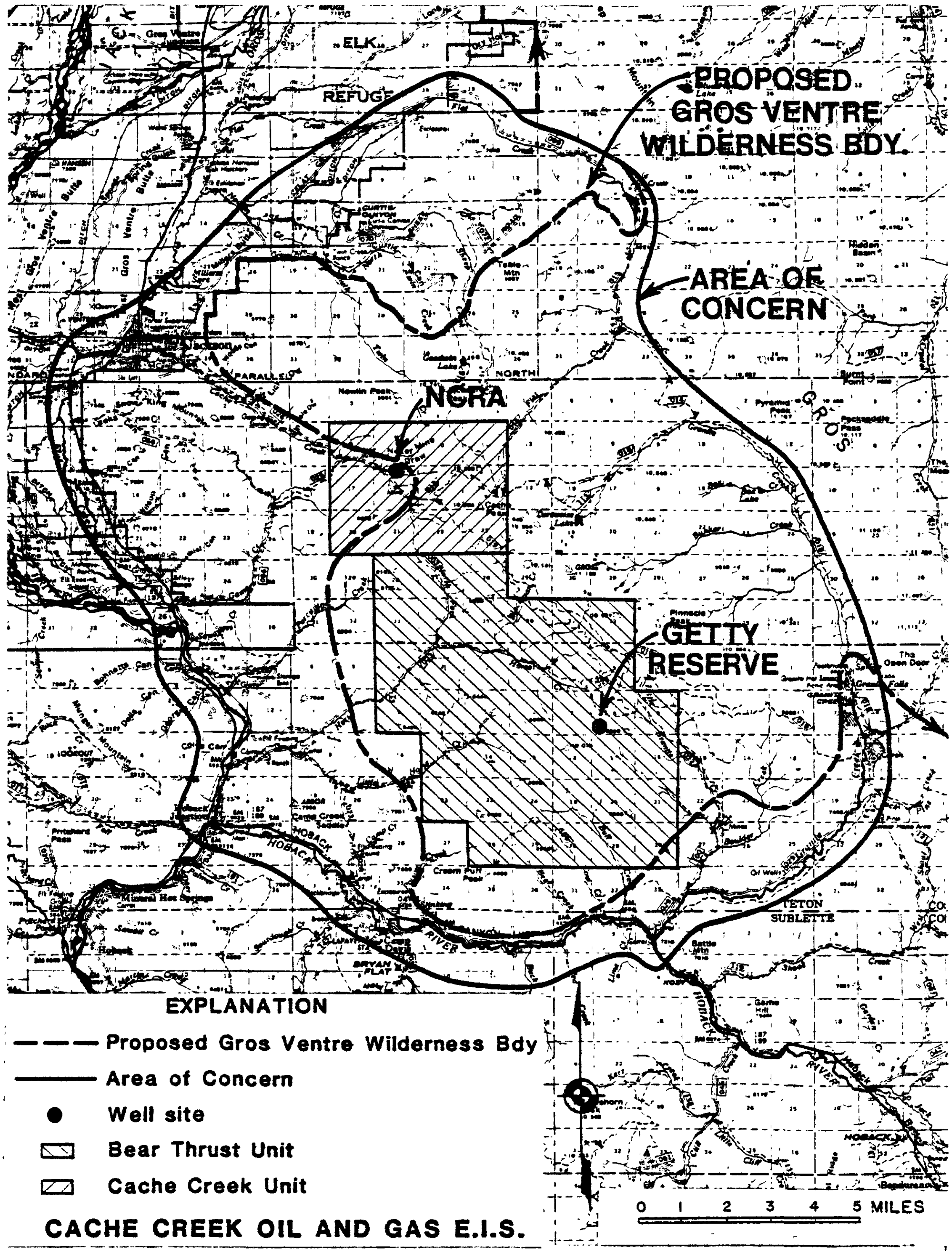


Figure 1.--Study area of report.

average noise level is 50 dB. During the 24-hour period there can be times when the noise level is higher than 50 dB, and many times when it is lower.

MAXIMUM SOUND LEVEL.--The greatest sound level during a designated time interval or event. More specifically, it is the greatest Fast A-weighted sound level of the event.

NOISE LEVEL.--The same as sound level, for sound in air. Some people use "noise" only for sound that is undesirable. A sound level meter does not, however, measure people's desires. Hence, there is less likelihood of misunderstanding if what is measured by a sound level meter is called sound level, rather than noise level.

SOUND.--It is basically a rapid variation in atmospheric pressure, and a sound level meter is an instrument that measures sound pressure. So that the entire range of audible sounds can be put on a reasonable scale, a scale based on logarithms and ratios is utilized, and an arbitrary unit, the decibel, has been created. The decibel scale ranges from 0 to 140. The loudness of sound depends also on the frequency (or pitch) of a sound. Thus, weighting networks have been designed to be utilized with the decibel scale. The A-weighted scale discriminates severely against low frequency sounds, and is the scale most approximating the human ear.

SOUND LEVEL.--The quantity in decibles measured by an instrument satisfying requirements of American National Standard Specification for Sound Level Meters S1.4-1971. FAST time-averaging and A-frequency weighting are understood, unless others are specified. The sound level meter with the A-weighting is progressively less sensitive to sounds of frequency below 1000 hertz (cycles per second), similar to the response of the ear. With FAST time averaging, the sound level meter responds particularly to recent sounds nearly as quickly as does the ear in judging the loudness of a sound.

STATISTICAL SOUND (NOISE) LEVELS.--Any of the statistical noise levels is given in terms of the value of the noise level which is exceeded for a stated percentage of the time period during which the measurement was made. The symbol for the noise level which is exceeded x percent of the time is L_x.

L_{99} is the noise level which is exceeded 99 percent of a time period (such as 24 hours).

L_{90} is the noise level which is exceeded 90 percent of a time period. It is used to describe the background or ambient noise level.

L_{50} is the noise level which is exceeded 50 percent of the time; it is the median level and indicates the average intensity.

L_{10} is the noise level which is exceeded 10 percent of the time, and is a good descriptor of fluctuating noise sources such as vehicular traffic, since it indicates the near-maximum levels which occur from grouped single events.

CLIMATE

GENERAL CHARACTERISTICS

The study area is located in the Snake River drainage climatological subdivision of Wyoming. The area consists of mountain foothills on the edges of the study area to the peaks of the Gros Ventre Mountain Range in the interior. The area is characterized by low and highly variable precipitation, low relative humidity, abundant sunshine, and moderate temperatures with large diurnal and annual ranges. As a result of the abundant sunshine received on southerly slopes and low precipitation, the majority of timber growth occurs on north-facing slopes. North-facing slopes retain more of the moisture from the winter snowpack than those with southern exposure (National Oceanic and Atmospheric Administration, 1960).

The climate on the lower slopes of the area is in the semiarid, middle latitude steppe. The upper slopes (which are above tree-line and characterized by a heavy winter snowpack) can be considered to be in the mountain (highland) climate, and small permanent snow fields exist year-round. Frequent mountain-generated thunderstorms and heavy showers occur in the area.

The climate of the study area is similar to that of Jackson, Wyoming. However, Jackson (elevation, 6,234 feet) is approximately 1,200 feet lower than the proposed Cache Creek wellsite (elevation, 7,520+ feet), and 2,200 feet lower than the proposed Little Granite Creek wellsite (elevation, 8,520+ feet). Average temperature, therefore, will be lower, and average precipitation higher for proposed sites in these areas because of their higher elevation.

The average monthly temperature for Jackson in July is approximately 61^{o}F, and for January is 16^{o}F, with a annual average of 38^{o}F (fig. 2).

During the summer, the temperature exceeds 90^{o}F an average of only two days per year, and the highest recorded temperature at Jackson (through 1974) is 101^{o}F. The coldest month is January, with an average minimum temperature of 6^{o}F. The temperature falls below 32^{o}F an average of 250 days per year, and the coldest recorded temperature at Jackson is -52^{o}F. These temperatures allow for a growing season of only 40 days at Jackson, and a growing season of 30 days average in the study area. Climatic data for Jackson, Wyoming, are summarized in table 1.

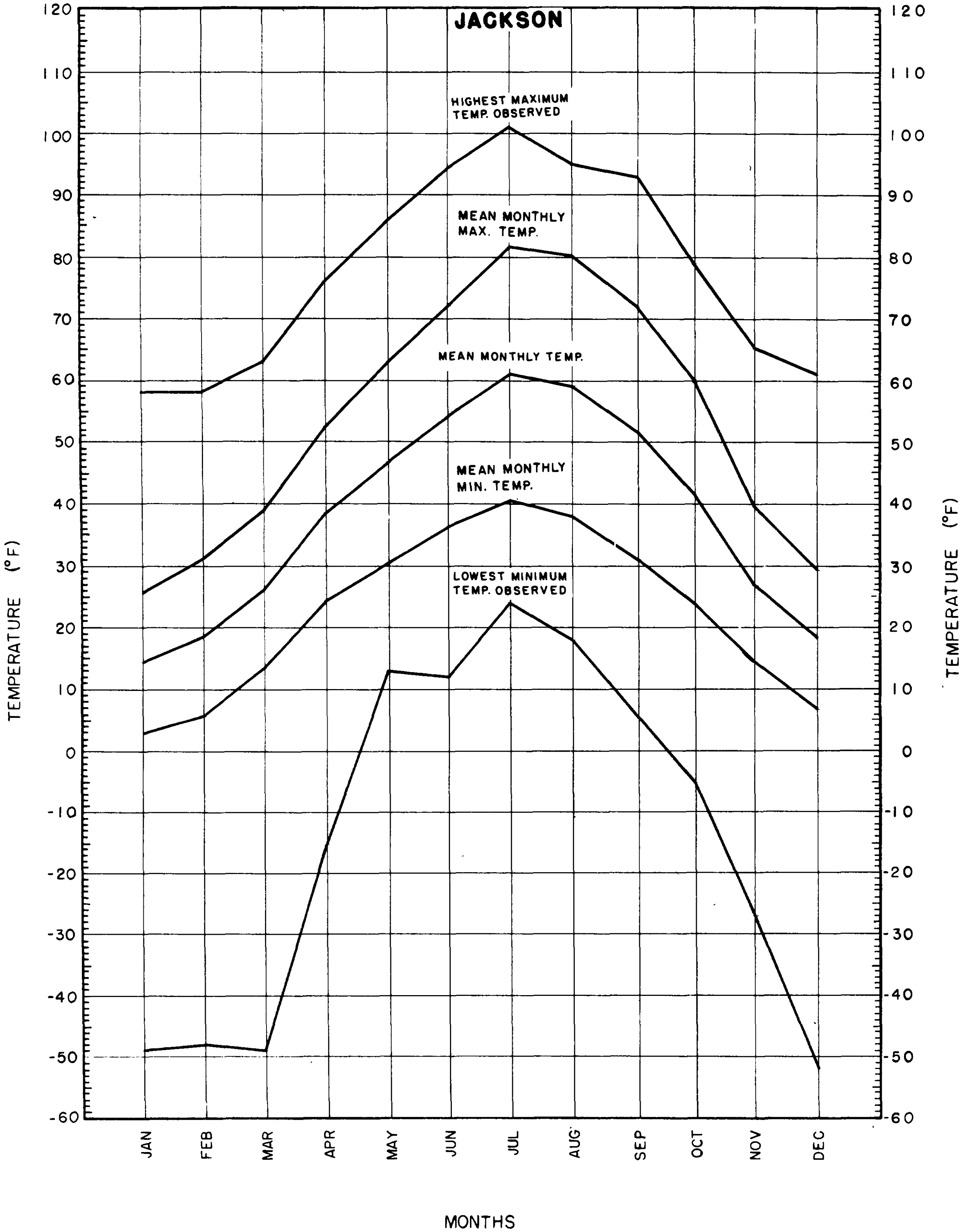


Figure 2.--Temperature data of Jackson Hole, Wyoming.

Table 1.--Climatological summary

JACKSON, WY **1951 - 1974** **43° 29' N** **110° 46' W** **6230 FT**

MONTH	TEMPERATURE (°F) MEANS: DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	EXTREMES: RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	MEAN NUMBER OF DAYS MAX: 90° AND ABOVE	MAX: 32° AND BELOW	MIN: 32° AND BELOW	MIN: 0° AND BELOW
JAN	26.2	6.0	16.1	55+	74	16	-49+	63	12	0	20	30	12
FEB	31.5	8.1	19.8	56+	63	5	-44	56	1	0	14	27	10
MAR	38.3	13.4	25.9	62	72	22	-32	66	4	0	7	30	5
APR	50.1	24.0	37.1	74+	69	23	-5	70	1	0	0	26	0
MAY	62.7	30.4	46.6	83	54	19	12	72	1	0	0	19	0
JUN	71.1	36.7	53.9	92	74	15	19	66	5	0	0	7	0
JULY	81.4	39.9	60.7	94	66	30	24+	68	1	1	0	3	0
AUG	79.7	38.1	58.9	94+	58	13	18	60	28	1	0	6	0
SEPT	70.0	31.0	50.5	93	56	18	14+	71	18	0	0	18	0
OCT	58.2	23.2	40.7	84	58	[illegible]	2	72	31	0	0	25	0
NOV	39.4	16.1	27.8	64	54	10	-27	55	16	0	7	28	4
DEC	27.3	6.5	16.9	50	65	5	-40	61	11	0	20	30	11
YEAR	53.0	22.8	37.9	94+	58	AUG 13	-49+	63	JAN 12	2	68	249	42

MONTH	PRECIPITATION TOTALS (INCHES): MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW, SLEET: MEAN	MAXIMUM MONTHLY	YEAR	GREATEST DEPTH	YEAR	DAY	MEAN NUMBER OF DAYS: 10 or MORE	50 or MORE	1.00 or MORE
JAN	1.69	4.91	69	.91	62	20	23.7	56.0	69	50.0	69	22	6	1	0
FEB	1.01	2.83	62	1.16	63	1	12.7	31.9	69	30.0	67	18	4	0	0
MAR	1.10	2.17	74	.58	72	3	13.1	25.0	54	32.0	62	23	4	0	0
APR	1.15	2.66	63	.87	68	2	8.0	24.0	67	23.0	62	1	4	0	0
MAY	1.47	2.58	57	1.01	66	10	1.5	11.0	53	8.0	73	1	5	1	0
JUN	1.76	4.82	67	1.04	67	14	.2	5.0	73	4.0	73	18	6	1	0
JULY	.75	1.91	73	1.00	62	13	.0						3	0	0
AUG	1.09	3.22	51	1.20	71	29	.0						4	0	0
SEPT	1.26	3.93	61	1.16	66	14	.4	5.0	61	5.0	61	21	4	1	0
OCT	1.09	3.21	72	1.17	72	10	2.6	10.5	71	6.0	71	1	4	0	0
NOV	1.19	2.98	73	.95	73	1	9.4	26.0	73	18.0	73	27	4	0	0
DEC	1.73	5.95	64	1.40	64	23	19.3	40.0	55	27.0	64	20	6	1	0
YEAR	15.29	5.95	DEC 64	1.40	DEC 64	23	90.9	56.0	JAN 69	50.0	JAN 69	22	54	5	0

+ ALSO ON EARLIER DATES

The average annual precipitation at Jackson is 15.29 inches. However, due to elevation differences, the annual precipitation at the Cache Creek well site is probably closer to 30 inches, and 45 inches at the Little Granite Creek wellsite. Precipitation may approach 70 inches on the peaks above the valleys. The Jackson precipitation averages approximately 1 inch each month, with peaks in early winter and late spring (fig. 3).

Heavy showers of short duration could cause flash flooding in the Cache, Flat, Granite, and Little Granite Creeks, especially if this heavy precipitation coincides with spring snow melt. Small unnamed drainages could also experience extreme flows for short periods of time. (See table 1.)

Table 2.--Estimated 24-hour precipitation values (inches) at the proposed NCRA Cache Creek site for various return periods

(Source: National Oceanic and Atmospheric Administration, 1973)

Return period (years)	2	5	10	25	50	100
24-hour precipitation	1.1	1.5	1.8	2.2	2.6	2.8

The maximum recorded 24-hour precipitation is 1.40 inches at Jackson. A value of 2 inches is possible at Cache Creek, and 3 to 4-inch value is possible on the peaks above the valleys. Snowfall per year at Cache Creek site will approach 200 inches (as opposed to the 91-inch value at Jackson), and 250+ inches at the Little Granite Creek wellsite. The high peaks of the area could expect 300+ inches per year. It is anticipated that the Cache Creek wellsite would have an average winter snowpack of 60 inches. The average snowpack at the Getty site will

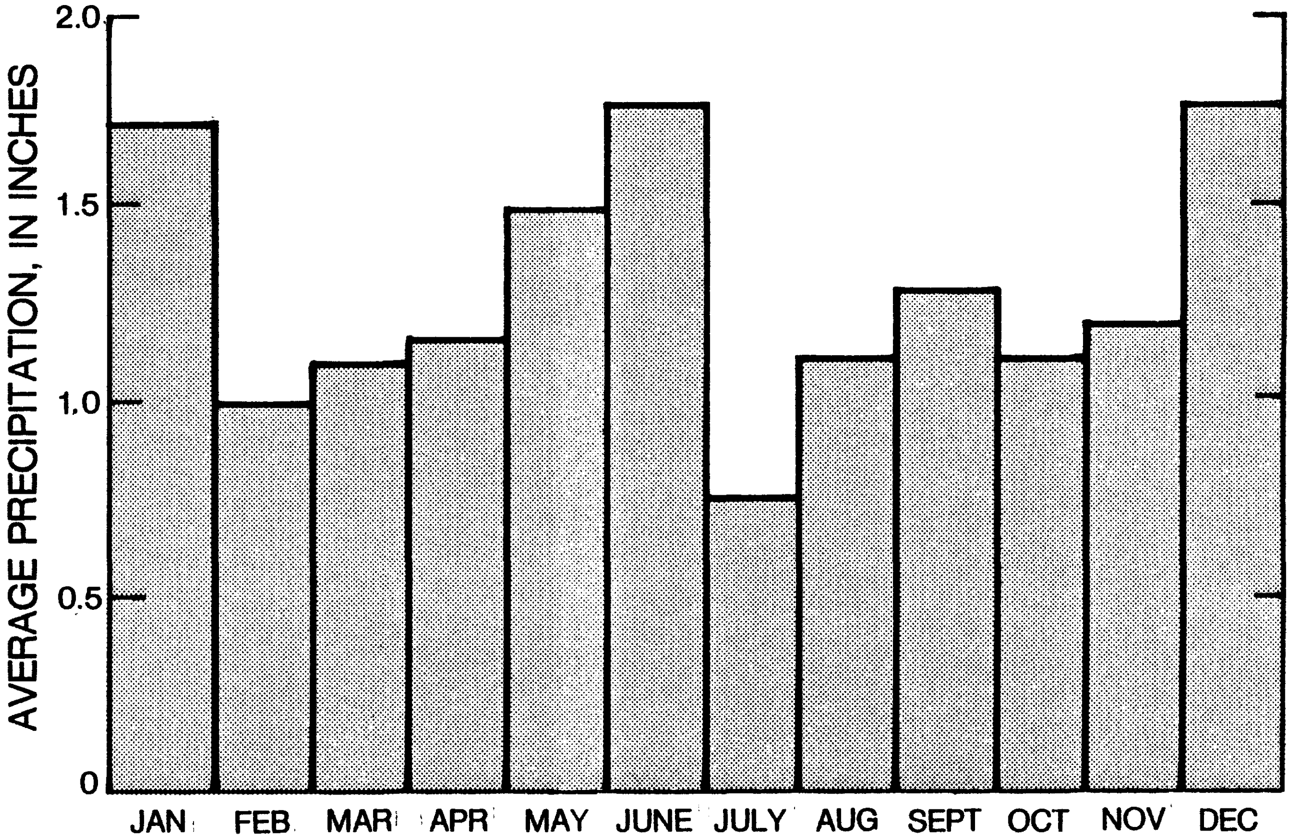


Figure 3.--Mean monthly precipitation at Jackson, Wyoming, weather station.

approach 85 inches. In many areas of the study area, the winter snowpack will be unstable, and avalanching will occur. If proposed wellsites are located in an area suspected of avalanche problems, the USFS should consult an avalanche expert and approve an avalanche control program prior to wellsite construction.

The greatest monthly snowfall at Jackson, where records are taken, was 50 inches. The mean annual lake evaporation for the site is 28 inches. Runoff is more thoroughly discussed in the Hydrology Supplementary Report (U.S. Geological Survey Open-File Report 81-410).

Very dry summers in the area are unusual and, therefore, episodes of high fire hazard periods are also rare. However, the appropriate USFS representative should be contacted prior to any flaring of gas for testing. Operators should be aware that if fire hazard risks are high, operations may be shut down until the risk period ends.

The prevailing wind directions at the Jackson Airport (13 miles north-northwest of Jackson, Wyoming) are south to southwest (190° to 210°) with an average wind speed of 5 to 10 miles per hour (mph). Wind in the study area will tend to be channeled by the various canyons and mountain ridges in the area. The northwest to southeast-tending Cache Creek Canyon will tend to channel the westerly component of the prevailing wind to the southeast, away from the town of Jackson. Frequent inversions occur in the Jackson Hole valley.

During the summer months, the winds tend to be calm (speeds less than 1 mph). Because of the relatively light, synoptic scale winds in the area, and frequent inversion episodes, the classic diurnal mountan-valley windflow pattern will occur frequently in canyons and valleys of the study area. Due to the difference in heating of the canyon slopes and the free air, an upslope or valley wind results, usually starting just after sunrise and lasting until just after sunset. The downvalley or mountain wind (drainage wind) is due to the uneven cooling of the free air and the canyon slopes. In the Cache Creek Valley this will result in a southeasterly wind in the day, and a north-westerly (toward the town of Jackson) wind at night. Potential inversion areas and valleys that will experience night-time drainage winds are outlined on plate 1.

FREQUENCY OF POOR VISIBILITY EPISODES AND THUNDERSTORM ACTIVITY

Since the alternative of helicopter drilling is being considered in this EIS, the possibility of prolonged helicopter down-time due to poor visibility or frequent thunderstorms must be assessed. Data gathered by Jackson Hole Airport observers from 1976 through 1980 are graphed in figure 4.[1] It indicates the frequency of observations of both less than 3-mile visibility and towering cumulus buildups, or thunderstorms. Data are based on an 11-hour observation day, 8 a.m. to 7 p.m., and hourly observations. Each hour an observation was made with a thunderstorm or poor visibility is counted as 1. The impacts of climate on the feasibility of a helicopter drilling operation will be thoroughly discussed in the Helicopter Supplement to the EIS.

---

[1]These data are on file with the Jackson Hole Public Library, located in downtown Jackson, Wyoming.

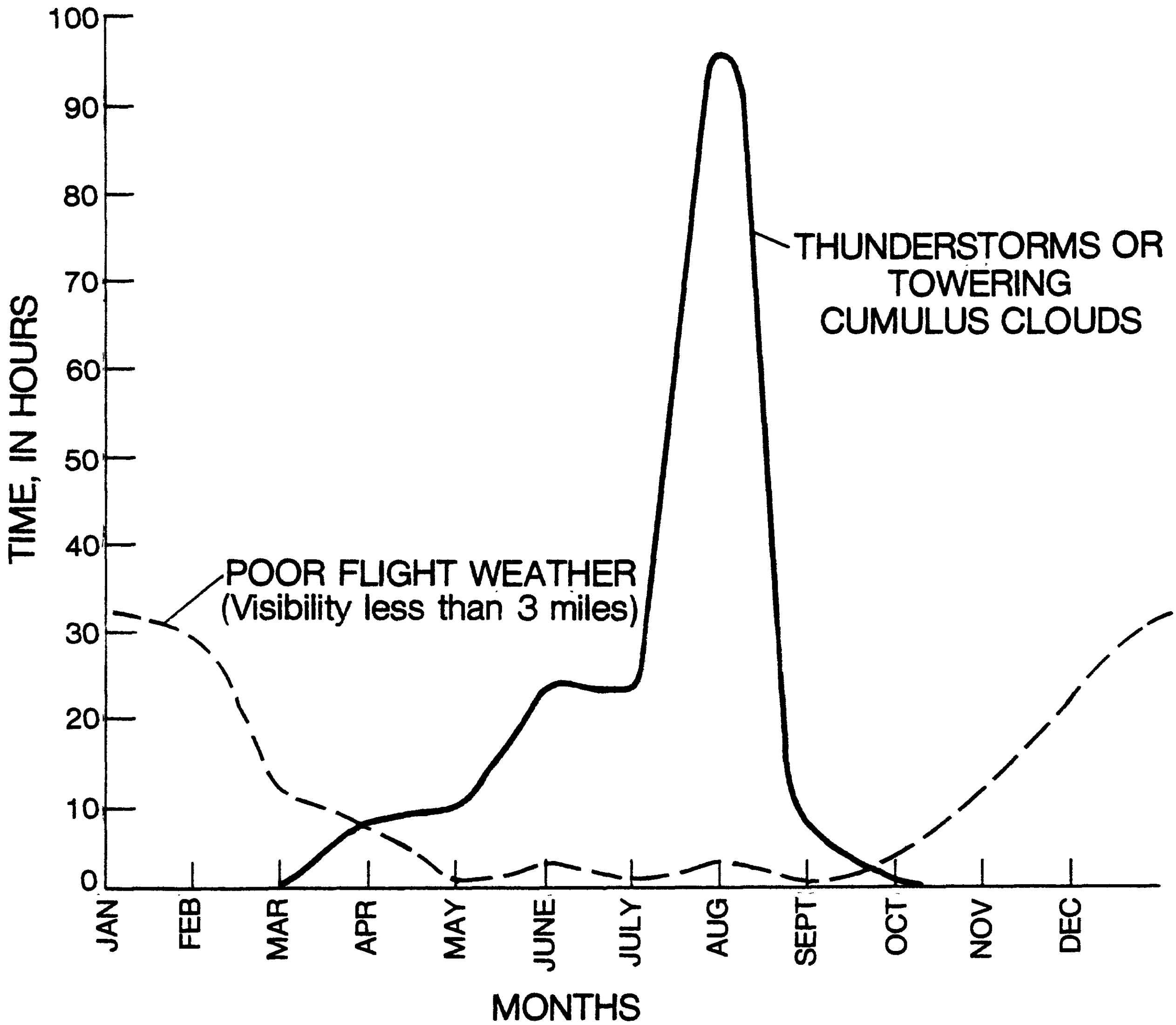


Figure 4.--Thunderstorm or towering cumulus clouds and poor flight weather observed at Jackson Hole airport.

CONCLUSIONS

The impact of oil and gas operations in the Area of Concern on climate will not be measurable. However, the following climatic considerations should be made in site selection, road construction, and rehabilitation:

Site Selection

1. Sites should be located out of identified flood hazard area.

2. Sites should be located out of identified avalanche tracks. (A USFS-approved avalanche control program may be required at sites located in unstable snowpack areas.)

Road Construction

1. Roads should avoid "dugways" and other snow accumulation (drift) areas that would make winter road maintenance difficult, or spring reopening of roads difficult.

2. Roads should be located on south exposures when possible, so that snowmelt and road dryout would occur early in spring.

3. Culverts and bridges should be designed to accommodate at least a 25-year storm.

4. Roads should not be located in recognized flood hazard areas as identified avalanche tracks.

Rehabilitation

1. Reserve pits should be pumped dry at the conclusion of operations, as the combination of high precipitation (including snowfall), cool temperatures, and low evaporation may not permit proper drying.

2. USFS-recommended seeds for revegetation should be utilized. Seeds should be selected for optimum growth given the short growing season, to facilitate rapid vegetation of the disturbed areas.

AIR QUALITY

GENERAL CHARACTERISTICS

Impacts to the air quality of the study area will vary from minor impacts for exploratory drilling operations to significant impacts in the event of intensive field development. The type, extent, and area of oil/gas development are important factors for determining the severity of air quality degradation resulting from field development.

The study area can be divided into two broad catagories: the upper bench areas and ridges, and narrow valleys. The upper benches and ridges have good potential to disperse any pollutants as they are more exposed to upper level prevailing winds, and are above the inversion levels. The narrow valley areas have poor potential for dispersion as pollutants would be restricted by the valley walls and frequent inversions. The largest of these valleys in the study area is the Cache Creek Valley. Within Cache Creek, trapped pollutants would have a potential of moving down canyon due to the orographic drainage winds. The pollutants would tend to pool in the vicinity of the town of Jackson because of potential inversions and the topography of the surrounding region (plate 1).

GOVERNING REGULATIONS AND EXISTING AIR QUALITY

The Clean Air Act of 1970 (as amended in 1977) established standards for seven catagories of pollutants (total suspended particulates (TSP), sulfur dioxide, nitrogen oxides, hydrocarbons, ozone, and lead). The National Ambient Air Quality Standards (NAAQS) and their maximum acceptable levels are listed in table 3.

Table 3.--National Ambient Air Quality Standards

(Source: Federal Register 36, no. 84, part II, April 30, 1971, p. 8186-8201)

(Note: Standards, other than those based on annual average or annual geometric average, are not to be exceeded more than once a year.)

Pollutant	Averaging time	Primary standard	Secondary standard	Measurement method
Carbon monoxide	8 hr	10 mg/m^3 (9 ppm)	Same	Nondispersive infrared spectroscopy
	1 hr	40 mg/m^3 (35 ppm)	Same	Nondispersive infrared spectroscopy
Nitrogen dioxide	Annual average	100 ug/m^3 (0.05 ppm)	Same	Colorimetric using NaOH
Sulfur dioxide	Annual average	80 ug/m^3 (0.03 ppm)		Pararosaniline method
	24 hr	365 ug/m^3 (0.14 ppm)		Pararosaniline method
	3 hr		1,300 ug/m^3 (0.5 ppm)	Pararosaniline method
Lead	Annual average	1.5 ug/m^3		
Suspended particulate matter	Annual geometric mean	75 ug/m^3	60 ug/m^3	High-volume sampling
	24 hr	260 ug/m^3	150 ug/m^3	High-volume sampling
Hydrocarbons (corrected for methane)	3 hr (6-9 a.m.)	160 ug/m^3 (0.24 ppm)	Same	Flame ionization detector using gas chromatography
Photo-chemical oxidants	1 hr	240 ug/m^3 (0.12 ppm)	Same	Chemiluminescent method

The TSP concentrations in the area should be similar to those found in Grand Teton National Park (table 4).

Table 4.--Total suspended particulate (TSP) concentrations at the Kelly Station, Grand Teton National Park

(Source: Department of Environmental Quality State of Wyoming, 1976 through 1979. Measurements in micrograms per cubic meter)

Year	Annual geometric mean	24-hour maximum
1976	11.0	91
1977	7.6	51
1978	7.7	42
1979	6.6	58

Background levels for the other criteria pollutants listed in table 3 are not available. There are no representative sampling stations near, or upwind of the study area. However, due to the areal remoteness from significant pollutant sources, the general air quality is probably very good.

There have been reports of poor air quality and haze in the Jackson area, particularly during winter cold episodes. It is probable that the haze results from pollutants produced by wood-burning stoves during times of cold, subsiding, high pressure air masses with strong surface inversions. These inversions tend to trap and accumulate the smoke from stoves. This situation could become a serious problem in the community with the continued growth of population and increased costs of hydrocarbon fuels.

In addition to the NAAQS discussed above, the Clean Air Act Amendments of 1977 established Prevention of Significant Deterioration (PSD) standards for areas classified as either Class I, Class II, or Class III. These classifications were established to protect relatively prestine areas (Class I), and areas already moderately impacted by pollutants (Class II) from further degradation. Presently, no Class III areas have been identified.

Both proposed drill sites (Getty and NCRA) are located in Class II areas.

This means that any increase in pollutant concentrations over the existing values shall be limited to the values presented in table 5. The study area is bordered by four mandatory Class I areas: Grand Teton National Park, Yellowstone National Park, Teton Wilderness Area, and the Bridger Wilderness Area. The proposed Gros Ventre Wilderness Area may receive Congressional approval and could become a Class I area. If this designation were to occur approximately two-thirds of the total study area would be within a Class I area.

Table 5.- Maximum allowable increments of deterioration, measured in micrograms per cubic meter

(Source: Clean Air Act Amendments of 1977)

Pollutant	Class I	Class II
Particulate matter:		
Annual geometric mean	5	19
24-hour maximum	10	37
Sulfur dioxide		
Annual arithmetic mean	2	20
24-hour maximum*	5	91
3-hour maximum*	25	512

*Maximum allowable increment may be exceeded once per year at any receptor site.

A designated responsible agency is required to review for compliance with PSD standards if any pollutant source is demonstrated to produce more than 250 tons/year of any one pollutant is listed in the NAAQS. (If the pollutant is not listed in table 3, the NAAQS will be taken as the present PSD standard).

As stated previously, baseline data on existing air quality in the area is limited. However, the air quality of the area is probably very good and there are no permitted PSD sources in the vicinity of Jackson that could effect the study area (R. Fisher, oral communication, 1981).

POTENTIAL POLLUTANT SOURCES

Air quality degradation to the study area would occur as a result of the following pollutant emissions if oil and gas development were approved:

1. Exhaust from drilling rig engines.
2. Exhaust from vehicular travel to and from the site.
3. Fugitive dust from traffic on access roads.
4. Gases encountered during drilling operations which could be released through the mud system.
5. Emissions from hydrocarbon processing plants and/or H_2S sweetening plants established in the event of field production.

EXHAUST FROM DRILLING RIG ENGINES

Engines used on drill rigs in the Overthrust Belt are primarily a diesel electric 3-engine setup. (Direct drive diesels are utilized in some cases, usually on more shallow holes. This setup utilizes smaller engines that may pollute less, but the additional light plant required would make this setup equivalent in emissions to diesel-electric.) If an Electro Motive Division of General Motors Corporation Engine Model 12-645E1 were utilized at full capacity, the exhaust constituets would be as indicated in table 6. Also indicated for comparative purposes are approximate emissions from a heavy duty diesel truck/bus at 60 mi/hr operation:

Table 6.--Exhaust constituents of GMC engine model 12-645E1

(Source: General Motors, Electro Motor Division, June 12, 1980)

	Full capacity operation	Diesel truck/bus at 60 mph*
Engine model 8-645E		
Rated output brake horsepower	1,100	---
Rated engine speed (rpm)	900	---
Nominal fuel rate (lbs/hour)	440	---
Exhaust constituents		
Carbon dioxide (CO_2) (percent)	6.62	---
Oxygen (O_2) (percent)	11.9	---
Carbon monoxide (CO) (grams/hour)	2,530	325
Unburned hydrocarbons (grams/hour as CH_2)	407	135
Oxides of nitrogen (NO_x) (grams/hour as NO_2)**	18,865	1,700
Sulfur dioxide, calculated (grams/hour as SO_2, with assumed .25 percent sulfur fuel)	998	---

*From the Compilation of Air Pollutant Emissions Factors (Third Edition) EPA August 1977 (PB-275-525) section 3.1.

**Based on summation of NO (by non-dispersive infra-red method) and NO_2 (by non-dispersive ultra-violet method). NO_x values based in chemiluminescent method will be approximately 11 percent lower than NO_x values stated above.

Assuming a typical exploratory drilling rig is working at 80 percent of the rated load capacity, in a typical drilling season, we have the following tons/year of constituents (table 7):

Table 7.--Typical emissions of drilling rig engines

(Source: Calculated from table 6 using Guidelines for Air Quality Maintenance Planning and Analysis, v. 10 (revised), PB-274-087, Environmental Protection Agency, 1977)

Source	Emissions (tons/year)
Unburned hydrocarbons, as CH_2	4.5
Oxides of nitrogen, as NO_2	*216.0
Sulfur dioxide, as SO_2	11.4
Carbon monoxide (CO)	29

*NO_x concentrations will be required to comply with the national ambient air quality standard (annual arithmetic mean of 100 micrograms (ug) per cubic meter). It is not anticipated that in normal operations NO_x would exceed 250 tons/year and therefore NO_x need not be considered under the PSD review process. If this constituent were to exceed 250 tons/yr, simple screening procedures indicate that the national ambient standard for NO_x would not be exceeded for values up to 1000 tons/year.

Under Wyoming Air Quality regulations, this engine setup would not be considered a Major Emitting Facility. Wyoming Air Quality regulations state a non-stationary source must produce 250 tons/year to be considered a Major Emitting Facility. (Note: All diesel engines must comply with Section 14 (d) of the Wyoming Air Quality Regulations. "The emission of visible air pollutants from diesel engines as determined by a qualified observer shall be limited to 30 percent capacity below 7,500 feet elevation except for period not exceeding ten consecutive seconds. This limitation shall not apply during a reasonable period of warmup following a cold start, or when undergoing repairs and adjustments following a malfunction.") Sulfur Dioxide (SO_2) is the only pollutant produced by this engine setup covered by the Wyoming Air Quality PSD standards, and at 11.4 tons/year, this pollutant is insignificant, and therefore need not be considered under the PSD Review Process.

Compressor stations along flowlines necessary in the event of extensive field development would probably emit in excess of 250 tons/year of NO_x, and as such, would be subject to a PSD review by the State of Wyoming. (Note: Final EIS on the Trailblazer Pipeline System, Federal Energy Regulatory Commission (FERC)/EIS-0018: Docket No. Cp-79-80 et al.)

EXHAUST FROM SERVICE VEHICLES

Emissions from vehicles would be at Federally established standards. At their maximum during the drilling operations, the emissions would be difficult to distinguish from tourist traffic emissions in the area. Upon abandonment of the well, the emissions would be non-existent; if production were established, the emissions from infrequent service vehicles would be negligible.

FUGITIVE DUST

Fugitive dust is estimated to be 50 tons for exploratory drilling (about 12 miles of access road, based on extensive utilization for about 6 months) see appendix 2. Watering of the roads or the use of dust-suppressing chemicals on the road along with control of vehicular speed would reduce fugitive dust by 20 percent to 50 percent, and their use should be required. (Note: Compilation of Air Pollutant Emission Factors (Third edition), EPA, August 1977 (PB-275-525) Sec. 11.2.) Car pooling will also tend to reduce fugitive dust, and its use should also be required. Use of a campsite on the wellsite will reduce road use with a corresponding decrease in fugitive dust. If production is established, the fugitive dust generated by infrequent service and maintenance vehicles would be negligible. However, since non-oilfield use of these roads could cause an increase in fugitive dust, it is recommended that the roads be closed to non-oilfield users.

GASES ENCOUNTERED WHILE DRILLING

The following gases may be encountered during drilling, and could possibly be released into the atmosphere if a blowout were to occur. This release would be short-term. A blowout event is rare in the drilling industry and would require immediate attention. If it were to occur it would be handled quickly.

Carbon Dioxide (CO_2)

Carbon dioxide (CO_2) is usually considered inert and is commonly used to extinquish fires. 1.5 times heavier than air, CO_2 will concentrate in low areas of quiet air. Humans cannot breathe air containing more than 10 percent of CO_2 without losing consciousness. Air containing 5 percent CO_2 will cause disorientation if breathed for 30 minutes or more, and air containing 10 percent CO_2 will cause disorientation in a few minutes.

The Threshhold Limit Value of CO_2 is 5,000 ppm. Short-term exposure to 50,000 ppm (5 percent) is tolerable. This gas is colorless and odorless, and can be tolerated in relatively high concentrations.

Methane (CH_4)

Methane (CH_4) is the major component of natural gas, and is colorless, odorless, and combustible. The chief danger from methane is explosion.

Mixtures of CO_2, H_2S, and CH_4 will burn if the total H_2S and CH_4 content, in any ratio, is about 25 percent or greater. The products of combustion will include sulfur dioxide (SO_2), carbon dioxide (CO_2), and water and gas, and is 2.3 times heavier than air. CH_4 can be tolerated without gas masks at 10 ppm, but at 1,000 ppm it can be lethal.

Sulfur Dioxide (SO_2)

SO_2 is produced by the burning of H_2S (hydrogen sulfide gas). The Threshhold Limit Value of SO_2 is 5 ppm. Short-term exposure to 10 ppm is tolerable. This gas is very irritating, and no instruments are required to detect it. In the event SO_2 is encountered, a Draeger Multi-Gas Detector and detector tubes should be available to establish the SO_2 concentration if the necessity should arise. A self-contained breathing unit should be available to anyone measuring SO_2 downwind from a flare.

Hydrogen Sulfide (H_2S)

Hydrogen sulfide gas (H_2S) is a highly toxic gas that has a specific gravity of 1.192 at 60°F (air has a specific gravity of 1 at 60°F). It is a highly reactive gas and will corrode standard metals. It burns with a blue flame and produces sulfur dioxide (SO_2), also a highly toxic gas. Hydrogen sulfide will disassociate itself from a natural gas stream in which it is mechanically mixed, and will tend to sink in the atmosphere due to its high specific gravity. The gas is, however, wind sensitive, and will be readily carried and diluted by winds. The toxicity to humans of H_2S is outlined in table 8.

Table 8.--Effects of H_2S gas on humans

(Source: Adapted from API Recommended Practices #59 and various H_2S Safety Publications)

H_2S (ppm)[1]	0 to 2 minutes	1 to 4 hours
1 to 10	Can smell.	Mild throat irritation; can smell.
20	Upper 8-hour safe limit. Can smell. Safe for 5 hours exposure.	Eye stinging, throat irritation. May kill smell.
50	Mild eye, throat irritation; kills smell in 15+ minutes.	Coughing, eye irritation, smell killed.
100	Coughing, irritation of eyes, kills smell in 3 to 15 minutes. Burning of throat.	Coughing, sharp eye pain, throat pain.
200	Kills smell quickly; severe throat and eye irritation; coughing.	Difficulty breathing, sharp eye pain, blurred vision. Can't smell.

[1]Values over 500 ppm will result in extreme weakness and death.

A major concern to the residents of Jackson, Wyoming, (as identified in the EIS Scoping Process) is the risk of a hydrogen sulfide (H_2S) blowout at the Cache Creek wellsite, causing H_2S to come down-canyon into the town of Jackson. It is possible that in a strong winter inversion, drainage winds would result in down-canyon winds that would cause H_2S to move down canyon to the town (plate 1 and fig. 1).

An analysis has been done for this "worst possible case situation" (i.e., infrequent meteorological conditions that would result in high H_2S concentrations moving down-canyon to Jackson). This analysis assumes an extreme H_2S blowout situation coupled with worst case meteorological conditions. The analysis indicates that H_2S concentrations passing by an individual at the mouth of the Cache Creek Canyon would be slightly less than 2 ppm in residential areas near the mouth of the canyon. (Appendix 1 gives a technical discussion of methods used to obtain these values.) H_2S will tend to pool and to accumulate in low areas because of the gas' high density. If a large uncontrolled blowout were to persist for 12 hours during the worst-case meteorological conditions, H_2S concentrations could build to 15 ppm near the mouth of Cache Creek Canyon.

In the event of such a major blowout, numerous federal regulatory agencies and company officials would be mobilized to evaluate the situation, and the well would be brought under control within several hours. Thus, chances of a large uncontrolled blowout extending to 12 hours is extremely minimal.

If American Petroleum Institute (API) Guidelines were followed in the drilling of this well, the chances for a hydrogen sulfide breakout of any magnitude would be minimal. Precautions for drilling in H_2S environments as provided for in draft USGS NTL-10, and API-recommended practices should be required for the safety of the drilling rig crew and the general public. These procedures include placement of H_2S monitors at critical locations around the drill rig. These monitors would be set to trigger a visual and an audible alarm if H_2S is detected above a certain level (about 10 ppm). Additional measures include placement of respirators for drillers' use, increasing the mud pH so that any H_2S bound in the mud would disassociate into sulfide and hydrogen ions, and addition of H_2S scavengers to the mud that would form stable compounds when they come in contact with H_2S.

In the event H_2S is encountered, the well could be shut-in with the blowout preventors (BOP), and any additional necessary safety precautions taken to ensure proper control of the H_2S. In the extremely unlikely event of an uncontrolled blowout, the rig would be flared in such a manner that the H_2S and natural gas would burn, forming a hot mixture of SO_2 that would readily volatize and disperse due to its heat generated bouancy. For safety purposes, all roads in the Cache Creek Canyon should be closed to all but authorized personnel during drilling and testing of known H_2S bearing geologic formations.

If, sour gas (natural gas contaminated with H_2S gas) were to be encountered in producible quantities in the drilling of an initial well, difficult problems for any future field development of the Cache Creek drainage would be presented. These problems would include the multiplication of risks to the residents of Jackson, Wyoming, possible degradation of nearby Class I areas, pipeline placement, processing plant placement, and severe negative consequences to recreational users of the Cache Creek drainage.

EMISSIONS FROM HYDROCARBON PROCESSING PLANTS

If discovered gas had to be treated in order to transport it by pipeline, a hydrocarbon processing/H_2S sweetening plant would be required (to remove the H_2S contaminant). Amoco is presently constructing the Whitney Canyon Gas Processing Plant near Evanston, Wyoming. The facility will emit 11.5 tons of particulates, 13.6 tons of CO, 2.3 tons of hydrocarbons, 150.3 tons of NO_x, and 13,644.5 tons of SO_2, based on an annual controlled operation basis (at its maximum design rate). A second natural gas processing facility is proposed for construction by Chevron in the Evanston area. On an annual controlled operation basis, the facility would emit 4,000 tons of CO, 1,150 tons of NO_x, 150 tons of SO_2, 200 tons of hydrocarbons, and 24 tons of particulates. (Additional information concerning the impact of these gas conditioning plants is available in the "Whitney Canyon and Carter Creek Natural Gas Processing Projects" environmental assessment prepared by the BLM.)

A gas processing plant in the Jackson Hole area would require a major plant siting study and further extensive environmental analysis, as the impacts to the air quality of the area would be significant and long term.

Any extensive treating required at the wellsite to remove trace gases will require review to determine its environmental suitability.

Air pollutant emissions from exploratory drilling would be minimal and temporary. Emissions in the event of field development would have moderate to high impacts depending on the type of oil/gas encountered and the area of development. The Cache Creek drainage presents special difficulties in Air Quality with a potential for high impacts due to strong drainage winds. The Little Granite Creek area presents only moderate Air Quality impacts because future wellsites would generally be located in high, open areas, if the USGS geologic analysis for the EIS proves to be valid.

NOISE IMPACTS

GENERAL CHARACTERISTICS

Backgound noise in the study area is generally very low (15 to 35dBA), with most of the noise intrusions associated with hikers, wildlife, picnickers, horse-back riders, cross-country skiers, snowmobiles, and wind-associated noises. The noise level would increase significantly in the immediate vicinity of the wellsites and access roads. The source of the increased noise levels include heavy equipment during the 3 to 10-week construction period, diesel drilling engines and generators during drilling (6-9 months), traffic on access roads, and in the event of field development, compressor stations and pump jacks. Most of these noises would be short term; however, if field development were to occur and if compressor stations, conditioning plants, and pump jacks were installed, long-term noise impacts from these facilities and maintenance traffic on access roads would be felt by users of the area.

To determine the average envelope of sound impact around drilling wellsites, access roads, oil pumping facilities, compressor stations, and also to determine present ambient noise levels, two General Radio Noise Level Meters were utilized by the author. A type 1565B (Serial No. C318988) hand-held meter and GR 1945 Community Noise Analyzer (Serial No. 138) were used. Sound measurements in dBA's were made at points around numerous drilling rigs, pump jacks, compressor stations, access roads, and at the proposed wellsites.

From those data, average envelopes of sound impacts were drawn around these components of exploratory drilling and field development. (These average levels are intended only to give approximate areas of impact as individual location types, drilling rigs, and weather conditions will have an effect on sound levels.) Time constraints for the EIS did not permit a more complete study of all these variables that would effect the level of noise impacts. However it is known that steep valley walls will cause sound to reviberate and will channel sound both downvalley and upvalley, whereas vegetation will attenuate sound levels.

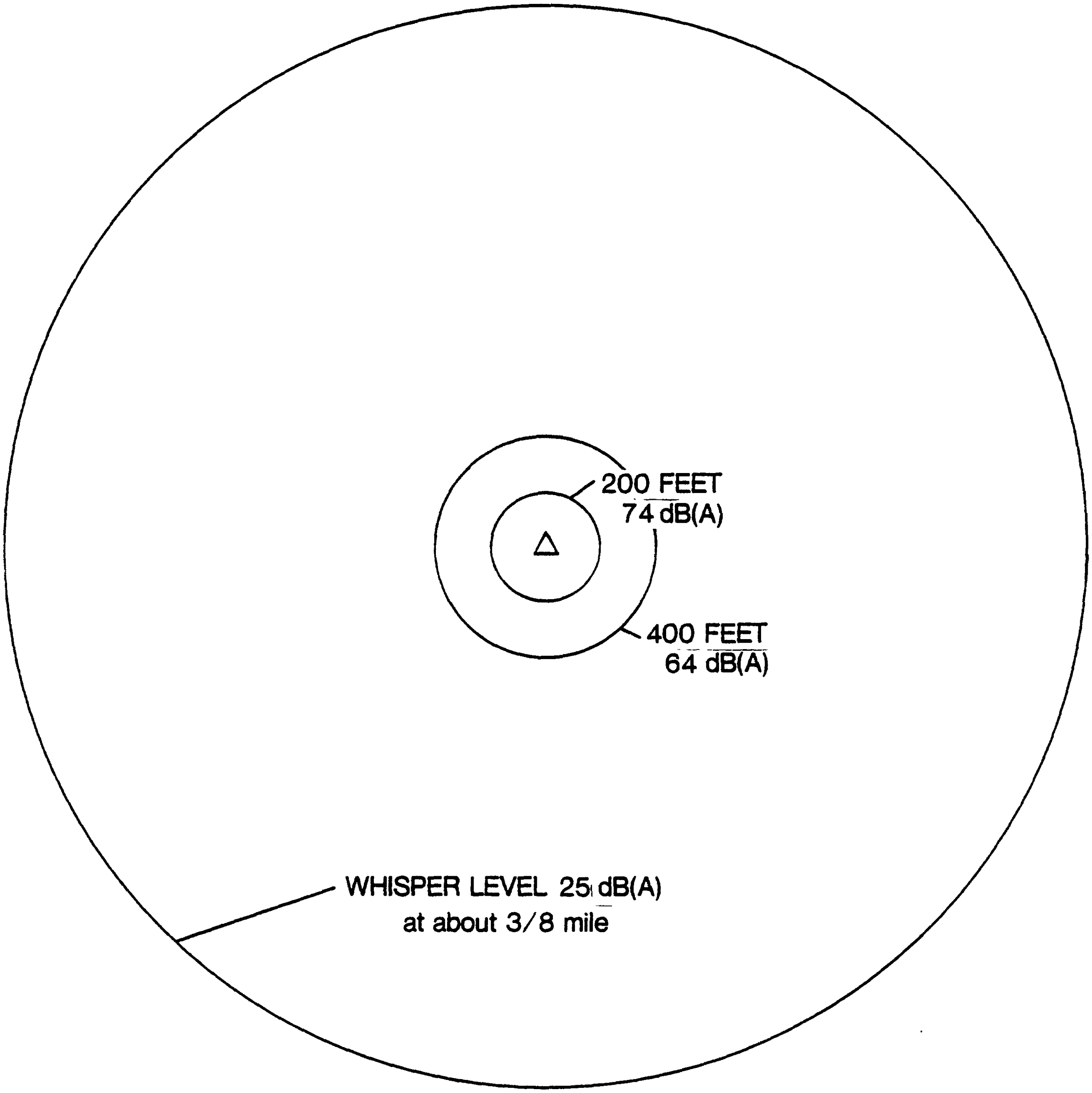
Presented in figures 5 through 8 are sound level averages for various exploratory and field components. These ranges are also plotted on a noise-level comparison chart in figure 9.

CONCLUSIONS

1. If roads in the town of Jackson are utilized for access to the NCRA's Cache Creek wellsite, noise levels would be intermittently increased over that of a typical quiet residential street (50 dBA) by as much as 35 dBA. This would result in a daytime nuisance to residents of the area and a high level of night-time sleep interference. It is therefore recommended that access to the Cache Creek wellsite via residential streets of Jackson be rejected.

2. Drilling operations, and access road use (both during drilling and field maintenance) will be a nuisance to recreational users of the area.

3. Drilling operations and access road use could tend to drive wildlife from ¼ to ½ mile from wellsites and access roads. For individual wellsites, this impact is not significant; however, for a developing field, these influence zones could overlap and will have an adverse effect on wildlife in the area. The potential also exists for access road influence zones to affect migratory routes for big game. What degree this adverse effect may have is unknown at this time.



MITIGATION: Require the use of Diesel-Electric type drilling rigs which produce constant noise levels over long periods of time as opposed to Direct Drive diesel engines which produce highly variable noise levels. Require the use of mufflers on drilling rig engines that would not adversly effect engine effeciency. These mufflers are capable of up to 30db reduction in noise levels at certain frequencies.

Figure 5.--Average envelope of noise levels aroung a drilling rig.

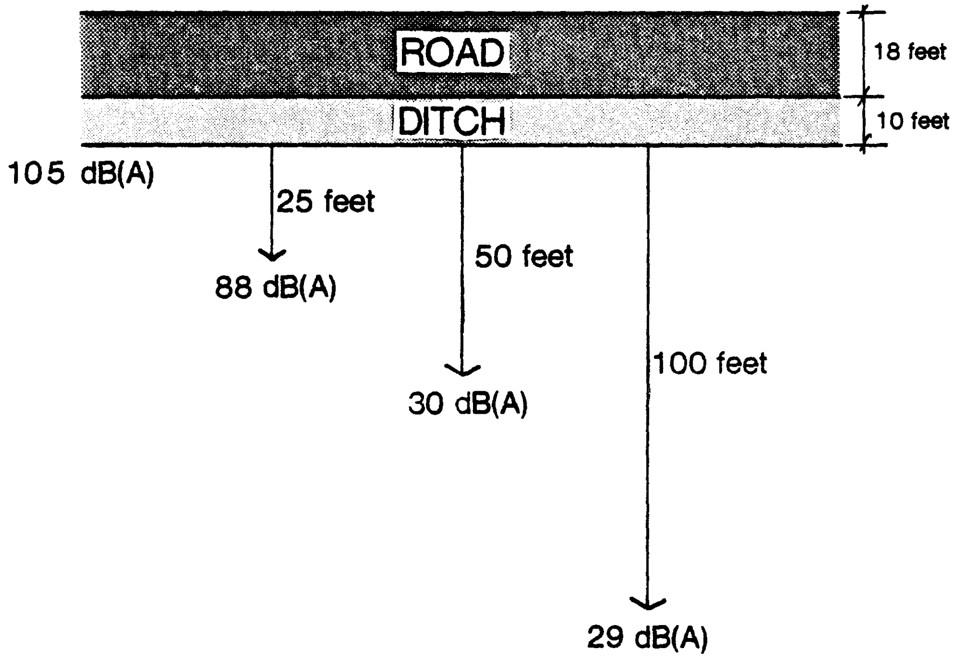
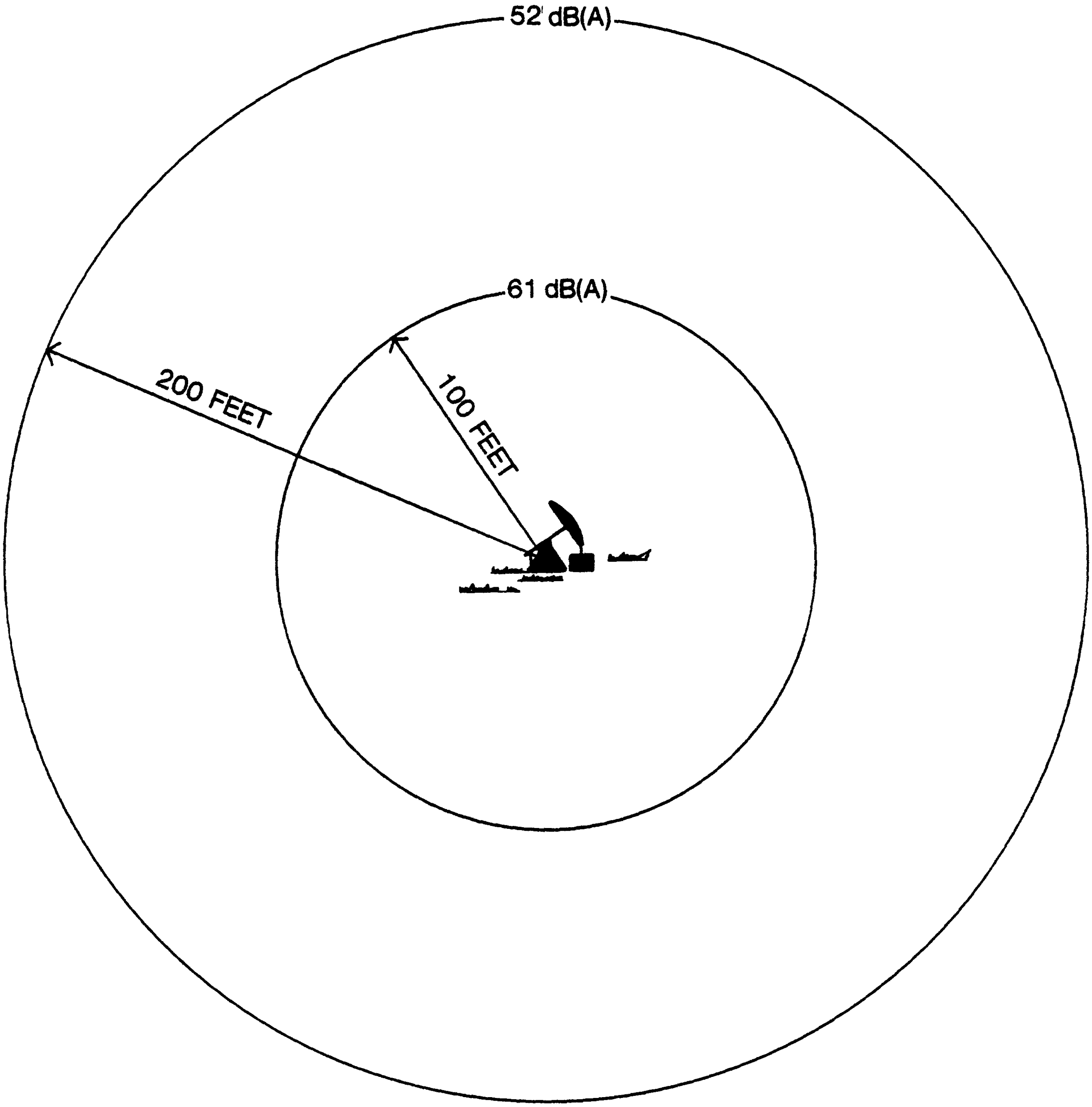
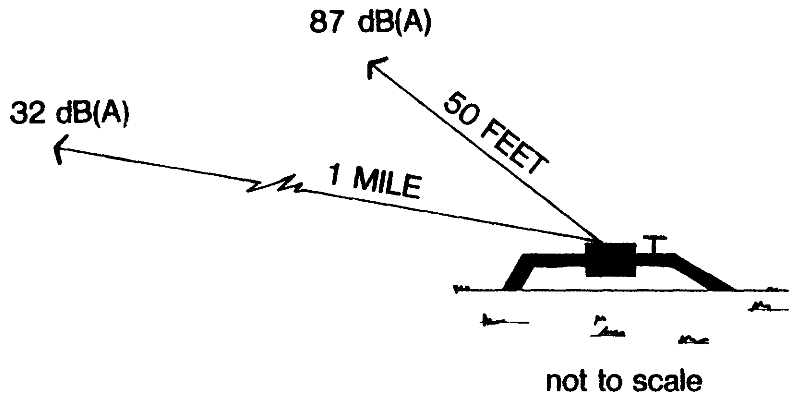


Figure 6.--Average envelope of noise levels around oil field access roads.



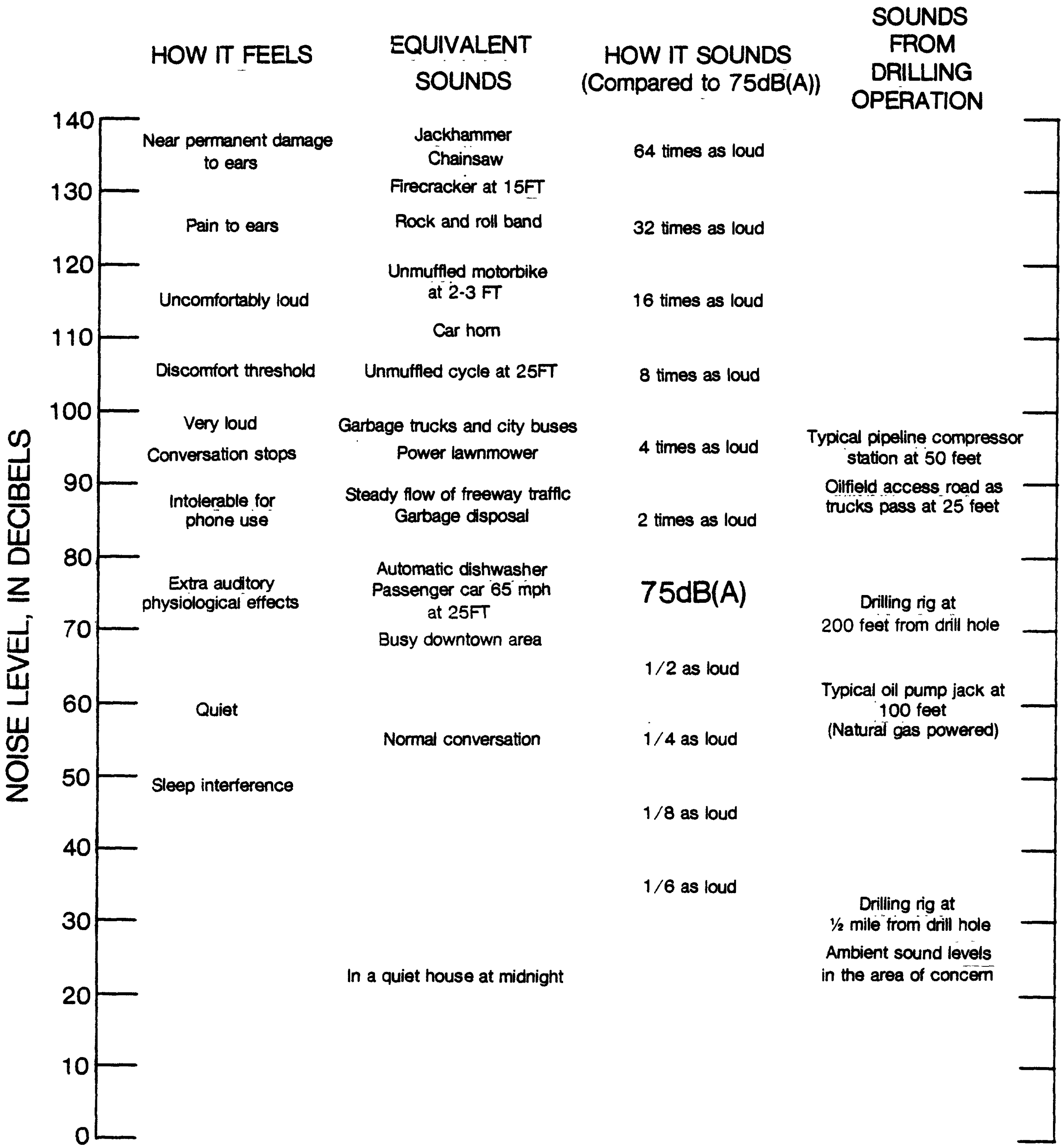
MITIGATION: Require use of electrically driven pumps that have no noise impact.

Figure 7.--Average envelope of noise impacts around a natural gas driven pump jack.



MITIGATION: Locate compressors away from residences and critical wildlife areas. Use of mufflers to reduce noise levels

Figure 8.—Average envelope of noise impacts around a typical pipeline compressor unit.



Modified from the Federal Energy Regulatory Commission (FERC)
Final EIS on Trailblazer Pipeline System FERC/EIS-0018 Docket No. CP79-80 et al

Figure 9.--Noise level comparison chart.

REFERENCES CITED

American Petroleum Institute, 1977, Drilling in H_2S: American Petroleum Institute Recommended Practices, no. 59, p. .

Becker, C. F., and Alyea, J. D., 1964, Temperature probabilities in Wyoming: Laramie, Wyoming, University of Wyoming Agricultural Experiment Station Bulletin 415, p. 125.

Bureau of Land Management, 1980, Environmental assessment on the Whitney Canyon and Carter Creek natural gas processing plants: Rock Springs, Wyoming, 193 p.

Camenzind, F. J., 1980, Wildlife survey--Cache Creek and Little Granite Creek, Bridger-Teton National Forest: U.S. Geological Survey Open-File Report 81-851, 71 p.

Craig, G. S., Jr., Ringen, B. H., and Cox, E. R., 1981, Hydrologic data for the Cache Creek-Bear Thrust environmental impact statement, near Jackson, Wyoming: U.S. Geological Survey Open-File Report 81-410, 53 p.

Everett, A. G., and Ghormley, L. L., 1979, An analysis of Clean Air Act prevention of significant deterioration provisions as they apply to wilderness areas: Rockville, Maryland, Everett and Associates, p. i-xiii, 67-70, 117-118.

Federal Energy Regulatory Commission, 1980, Final environmental impact statement on the Trailblazer pipeline system: Washington, D.C., FERC/EIS-0018, Docket No. CP79-80 et al., p. 71-78.

Greenwood, D. R., Kingsbury, G. L., and Cleland, J. G., 1979, A handbook of key Federal regulations and criteria for multimedia environmental control: U.S. Environmental Protection Agency, Industrial Environment Research Laboratory, p. 29-36, 167-168.

Mahoney, J. R., and Spengler, J. D., 1975, Meteorological content of environmental impact statements, in Lectures on air pollution and environmental impact analysis: American Meteorological Society, p. 275-291.

Miller, M. L., Everett, A. G., Moeng, F. J., Winges, K., Pringle, D., and Lavery, T., 1980, Analysis of the impact of air quality modeling on siting limitations for natural gas desulfurization facilities: American Petroleum Institute Publication No. 4332, p. VII-1.

National Oceanic and Atmospheric Administration, 1960, Climate of Wyoming, in Climatography of the United States, no. 60: U.S. Department of Commerce, p. 1-4.

_____1970, Climate of Wyoming, in Climatography of the United States, no. 60: U.S. Department of Commerce, p. 3.

_____1978, Climate of Wyoming, in Climatography of the United States, no. 60: U.S. Department of Commerce, p. 12.

Pasquill, F., 1975, The dispersion of material in the atmospheric boundary layer--the basis of generalization, in Lectures on air pollution and environmental impact analysis: American Meteorological Society, p. 1-33.

Turner, B. D., 1970, Workbook of atmospheric dispersion estimates, U.S. Environmental Protection Agency, p. 1-84.

U.S. Environmental Protection Agency, 1971, Air programs; National primary and secondary ambient air quality standards (revised): Federal Register, 36 FR 40 : 22384 as amended at 40 FR 40 : 7043 and 41 FR 40 : 11253.

_____1977a, Compilation of air pollutant emission factors, 3d ed.: p. 106, 409-412.

_____1977b, Procedures for evaluating air quality impacts of new stationary sources, in Guidelines for air quality maintenance planning and analysis: v. 10, p. 4:1-4:38.

U.S. Geological Survey, 1979, Unusual environmental analysis, NCRA's proposed Cache Creek test well, Teton County, Wyoming: Rock Springs, Wyoming, p. 32-40.

U.S. Soil Conservation Service, 1978, Summary of snow survey measurements in Wyoming: Washington, D.C., U.S. Government Printing Office, p. 153, 166.

Van der Hoven, I., 1975, Federal Government requirements for environmental impact assessment, in Lectures on air pollution and environmental impact analysis: American Meteorological Society, p. 275-291.

Appendix 1

Correspondence with Agencies on Specific Topics

United States Department of the Interior

GEOLOGICAL SURVEY
P.O.Box 1170
Rock Springs, Wyoming 82901

September 25, 1980

Environmental Protection Agency
EPA-8AH-A
Attn: Mr. Richard Fisher
1860 Lincoln
Denver, Colorado 80295

Dear Mr. Fisher:

In recent discussions I have had with Mr. John Dale (Technical Advisor) regarding the Air Quality section of the Cache Creek-Bear Thrust EIS, Mr. Dale indicated that you would be able to provide me with information on the EPA Valley Rough Terrain Dispersion Model (EPA-450/2-77-018). Use of this model would provide very useful information for the portions of the EIS addressing possible Hydrogen Sulfide (H_2S) concentrations down canyon from the proposed Cache Creek wellsite, located six miles up the Cache Creek valley from the town of Jackson, Wyoming.

Mr. Dale indicated to me that it might be possible for you to run this program for me, and to calculate worst case concentrations (in ppm) at Jackson, Wyoming, and other points closer to the wellsite for varying gas emission rates at the wellsite. In order to facilitate your obtaining this information for me, I am providing you with the following background material:

1. The residents of the town of Jackson, Wyoming, are understandably concerned that in the event of a gas blowout containing H_2S at the proposed Cache Creek wellsite that concentrations of H_2S has could travel down canyon to the town of Jackson. I have attached a topographic map indicating the proposed Cache Creek wellsite and the town of Jackson.

2. Wellsites in Wyoming Overthrust Belt locations can produce gas to 40 million cubic feet per day with up to 15% H_2S. However, in a blowout situation, it is not anticipated that more than 5 million cubic feet per day would exit an uncontrolled well in an extreme case. The table below presents calculated emission rates for a .5 to 5 million cubic feet per day at 15% H_2S. Exit velocities would be highly variable in a blowout situation.

.5 million cubic feet gas/day	37 gm/sec. of H_2S
.725 million cubic feet gas/day	54 gm/sec. of H_2S
1 million cubic feet gas/day	75 gm/sec. of H_2S
2 million cubic feet gas/day	149 gm/sec. of H_2S
3 million cubic feet gas/day	224 gm/sec. of H_2S
4 million cubic feet gas/day	298 gm/sec. of H_2S
5 million cubic feet gas/day	373 gm/sec. of H_2S

3. Any blowout would likely occur at the floor of the rig or from the mud tanks and/or shale shaker, giving an approximate stack height of 20 feet. In the event H_2S was channelled to a flare through a choke system, the stack height would be minimal (in this case SO_2 is produced which in my opinion would readily volatize and/or disperse due to its heat generated buoyancy).

4. I would like to possibly be able to compare worst possible case concentrations (E or F stability, minimal down-canyon winds) with values in an average case (standard meteorology).

Please contact me regarding this request at 307-362-6422. Thank you for any aid and information you can provide.

Sincerely yours,

Paul Kruger
Cache Creek-Bear Thrust EIS
Task Force Member

Enclosure

PKruger:ma

cc: John Matis-TFL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
1860 LINCOLN STREET
DENVER, COLORADO 80295

REF: 8AH-A

Mr. Paul Kruger
Cache Creek - Bear Thrust EIS
Task Force Member
USGS, P.O. Box 1170
Rock Springs, Wyoming 82901

Dear Mr. Kruger:

In your letter to me dated September 25, 1980, you requested some estimates of the expected impact of hydrogen sulfide (H_2S) from a gas well blowout in the Cache Creek 9 kilometers southeast of Jackson, Wyoming. In response, I have prepared some estimates of concentrations at Jackson using a steady state ventilated box model. In addition, I have made an estimate of the impact on the terrain surrounding the well. Both of these computations are made assuming an accidental release of H_2S at an elevation of about 7500 feet MSL in the Cache Creek.

The ventilated box model approach, while simple, is a good method to estimate maximum instantaneous concentrations at the mouth of Cache Creek during nighttime drainage conditions. Among the assumptions made in this model application are that the mean width of the Cache Creek drainage is 2000 m, the mean wind speed is constant, the drainage flow is completely decoupled from the geostrophic wind, the concentrations of H_2S in the ventilated box are distributed homogeneously but do not leave the Cache Creek drainage, there is no deposition, and there are no chemical reactions occurring. Tables 1-7 give expected instantaneous H_2S concentrations for various meteorological scenarios that might exist at the mouth of the Cache Creek for the seven release rates that you provided. Notice that higher wind speeds result in lower concentrations since there is a greater amount of air passing by the source, and thereby, a greater mass of air into which the H_2S may mix. Similarly, a greater mixing height allows for a larger area unto which the H_2S may mix resulting again in greater dilution and lower concentrations. While it is assumed in this exercise that every bit of emitted H_2S reaches Jackson, these estimates may not represent the highest concentrations expected for the given conditions. Other meteorological phenomena normally present over Northwestern Wyoming usually result in poor dilution and pooling of pollutants in low lying areas.

Pooling is highly likely in Jackson because of the frequent presence of subsiding high pressure air masses, snow cover, and orographic draining. These meteorological phenomena cause surface or near surface inversions (which are nearly always present) which may trap pollutants like H_2S in a very shallow layer near the surface in Jackson. Depending on the strength of drainage flows out of Jackson, this pooling of air may result in accummulations of high concentrations over a short period of time. For instance, if a release of 373 gm/s were made at the well site for a period of 12-hours, the amount of H_2S reaching Jackson would be 1.6×10^7 gm. Assuming that the H_2S were allowed to accummulate over Jackson in an atmospheric box with dimensions 2000m square by 200m high, the concentration after 12 hours would be 14.5 ppm. The generally accepted threshold limit value or inhalation limit acceptable for industrial exposure over 8 hours is 10 ppm, although the threshold odor value is only between .001 ppm and .00001 ppm.

If the gases released at the well site escape the drainage flow of Cache Creek which might reasonably happen during the day, yet still disperse under widespread stable atmospheric conditions, for instance beneath a subsidence inversion, the EPA model "Valley" that you referenced in your letter may be applied. In this case, the highest concentration would be expected directly downwind at the nearest terrain obstacle intersecting the centerline of the plume. Assuming that the gas eminates from a height of a 6m and is not flared the plume will intersect terrain within tens of meters of the well and thereby cause concentrations of several hundred ppm's in less than one hour. However, a better estimate of the expected plume rise is necessary to make more precise estimates of maximum expected concentrations on high terrain. If you would like us to provide you with these estimates, we will need additional stack parameters including stack gas, temperature, velocity, and stack diameter.

It seems that the potential for high concentrations of H_2S occurring in Jackson as a result of a well blowout in Cache Creek should not be ignored. If more refined estimates of concentration are needed, I would suggest collecting meteorological data at several points in the Cache Creek and at Jackson, and possibly conducting tracer gas studies to determine the dynamic behavior of the plume in the Cache Creek/Jackson drainage basin.

If you wish to discuss these results, please feel free to call me.

Sincerely yours,

Richard W. Fisher
Regional Meteorologist

Enclosures

bcc: Dennis Sohocki, 8W-EE
John Dale, 8AH-A
John Matis, USGS

Mixing Height (m)	Drainage Wind Speed (m/s) 1	2	3	4
100	.133	.067	.045	.033
200	.067	.033	.022	.017
300	.045	.022	.015	.012
500	.027	.014	.009	.006
700	.019	.009	.006	.005

Table 1 - Concentrations of H_2S in ppm expected at Jackson, Wyoming, from a release of 0.5 million ft^3 of gas per day at a Cache Creek wellsite using a ventilated box model. Mean width of valley is 2000m.

Mixing Height (m)	Drainage Wind Speed (m/s) 1	2	3	4
100	.195	.097	.065	.049
200	.097	.049	.032	.025
300	.065	.032	.022	.017
500	.039	.019	.013	.010
700	.028	.014	.009	.007

Table 2 - Concentrations of H_2S in ppm expected at Jackson, Wyoming, from a release of 0.725 million ft^3 of gas per day at a Cache Creek wellsite using a ventilated box model. Mean width of valley is 2000m.

Mixing Height (m)	Drainage Wind Speed (m/s) 1	2	3	4
100	.270	.136	.090	.068
200	.136	.068	.045	.034
300	.090	.045	.030	.022
500	.054	.027	.018	.014
700	.039	.019	.013	.010

Table 3 - Concentrations of H_2S in ppm expected at Jackson, Wyoming, from a release of 1.0 million ft^3 of gas per day at a Cache Creek wellsite using a ventilated box model. Mean width of valley is 2000m.

Mixing Height (m)	Drainage Wind Speed (m/s) 1	2	3	4
100	.537	.269	.179	.134
200	.269	.134	.089	.067
300	.179	.089	.060	.044
500	.107	.054	.036	.027
700	.076	.038	.025	.019

Table 4 - Concentrations of H_2S in ppm expected at Jackson, Wyoming, from a release of 2.0 million ft^3 of gas per day at a Cache Creek wellsite using a ventilated box model. Mean width of valley is 2000m.

Mixing Height (m)	Drainage Wind Speed (m/s) 1	2	3	4
100	.808	.404	.269	.202
200	.404	.202	.135	.101
300	.269	.135	.089	.067
500	.162	.081	.054	.040
700	.115	.058	.038	.029

Table 5 - Concentrations of H_2S in ppm expected at Jackson, Wyoming, from a release of 3.0 million ft^3 of gas per day at a Cache Creek wellsite using a ventilated box model. Mean width of valley is 2000m.

Mixing Height (m)	Drainage Wind Speed (m/s) 1	2	3	4
100	1.074	.537	.358	.269
200	.537	.269	.179	.134
300	.358	.180	.120	.090
500	.215	.107	.071	.054
700	.154	.077	.051	.038

Table 6 - Concentrations of H_2S in ppm expected at Jackson, Wyoming, from a release of 4.0 million ft^3 of gas per day at a Cache Creek wellsite using a ventilated box model. Mean width of valley is 2000m.

Mixing Height (m)	Drainage Wind Speed (m/s) 1	2	3	4
100	1.345	.673	.448	.336
200	.673	.338	.224	.168
300	.448	.224	.149	.112
500	.269	.135	.089	.067
700	.192	.096	.064	.048

Table 7 - Concentrations of H_2S in ppm expected at Jackson, Wyoming, from a release of 5.0 million ft^3 of gas per day at a Cache Creek wellsite using a ventilated box model. Mean width of valley is 2000m.

United States Department of the Interior

GEOLOGICAL SURVEY
P. O. Box 1170
Rock Springs, Wyoming 82901

July 18, 1980

Department of Environmental Quality
Air Quality Division
401 West 19th Street
Cheyenne, Wyoming 82002

Attn: Mr. Randolph Wood

Dear Mr. Wood:

As you may be aware, the United States Forest Service (USFS) and the United States Geological Survey (USGS) are presently in the process of preparing an Environmental Impact Statement (EIS) on oil and gas exploratory drilling operations in the vicinity of Jackson, Wyoming (I have attached a copy of the scoping statement for your information).

I am presently in the process of writing the Air Quality and Climate portions of the Draft EIS, and I would greatly appreciate it if you would respond to some of my questions regarding the Wyoming Air Quality regulations. Also, if you could,offer informal comments on my preliminary data and conclusions, so that I might further address issues or concerns you may have.

Recent data received from the Electro-Motive Division of General Motors Corporation (GM/EMD) has given me the following information on emissions rates for several models of GM Diesel Electric engines utilized in drilling rigs:

GASEOUS EMISSION DATA FOR
LAND DRILLING RIG ENGINES
MANUFACTURED BY ELECTRO-MOTIVE DIVISION OF GENERAL MOTORS CORPORATION

EMD Rated Conditions of 90°F Air Temperature at Sea Level

Engine Model	8-645E1	12-645E1	8-645E4B	12-645E4B
Rated Output Brake Horsepower	1,100	1,650	1,650	2,500
Rated Engine Speed - RPM	900	900	900	900
Nominal Fuel Rate - LB/HR	440	650	595	890
Exhaust Constituents				
Carbon Dioxide (CO_2) percent	6.62	6.78	5.75	5.75
Oxygen (O_2), percent	11.9	11.6	13.1	13.1
Carbon Monoxide (CO) grams/hour	2,530	5,544	1,545	4,661
Unburned Hydrocarbons grams/hour as CH_2	407	693	694	852
Oxides of Nitrogen (NO_x)* grams/hour as NO_2	18,865	24,866	21,245	34,910
Total Suspended Particulates(TSP)	- No Data Available -			

	8-645E1	12-645E1	8-645E4B	12-645E4B
Sulfur Dioxide - calculated; grams/hour as SO_2 with assumed o.25% sulfur fuel	998	1,474	1,350	2,030
Volatile Organic Compounds (VOC)	- No Data Available -			

*Based upon summation of NO (by non-dispersive infra-red mothod) and NO_2 (by non-dispersive ultra-violet method).

NO_x values based on chemiluminescent method will be approximately 11% lower than NO_x values stated above. (See attached explanation.)

If one assumes that two model #8-645E1 engines are utilized on the average drilling rig to be drilling in the area of concern, we obtain the following pollutant constituents in tons/year (based on a 6-month drilling season with engines operating continuously at .8 capacity):

Unburned hydrocarbons, as (CH_2)	3.0 tons/year
Oxides of nitrogen, as (NO_2)	144 tons/year
Sulfur dioxide, as (SO_2)	7.6 tons/year
Carbon Monoxide	19.2 tons/year

It is my understanding that, per Wyoming Air Quality Standards and Regulations Section 24 (Prevention of Significant Deterioration), a non-stationary source must emit 250 tons/year of one or more constituents to be considered a major emitting facility, and that, since an exploratory drilling rig is a mobile, non-permanent (drilling should last from 6 to 9 months) source emitting less than 250 tons/year of any constituent, it is not a major emitting facility, and as such, is exempt from any special permits or provisions per Section 24:13(b). Is this a correct interpretation of these regulations?

The only consitituents covered by PSD standards are SO_2 and TSP (Table #1 p.50 of Air Quality Standards and Regulations). TSP for these engines is considered negligible. SO_2 impacts will also be slight at 7.6 tons/year. However, I have calculated approximations for SO_2 concentrations downwind from a drilling rig using the basic (not terrain modified) Pasquill-Gifford Equation[1] for a ground level source at Class C stability, and an average 6 mph wind speed. It was found that PSD standards for SO_2 (in ug/m^3) for a Class I area are not violated from 1.2 miles out, and that Class II standards are not violated from .4 miles out. This degradation is very localized and would cease after drilling operations are complete. However, although no PSD standards presently exist for oxide of nitrogen, a drilling rig does emit a considerable amount of NO_2 (144 tons/year) and if a PSD standard similar to the SO_2 standard is established, the possible standard for NO_x would be met for a Class I area from 5 miles out and for a Class II area from 1.4 miles out (again for Class C stability and a 6 mph wind speed).

1. D. Bruce Turner - Workbook of Atmospheric Dispersion Estimates, EPA

Conceivably if several drilling rigs were to be operating in a Class I area at the usual Wyoming State Spacing of 1 gas well per section, a larger area could be in violation of possible NO_x Class I and Class II standards, and Class I SO_2 standards. Although these wells should, under normal conditions, be operating for only 6 to 9 months, it is conceivable that on a problem hole the rig could be in place for 2 to 3 years. Would the rig then require special permitting? (That is, would it no longer be considered a temporary source?)

Several Class I areas exist in the area (Yellowstone National Park, Teton Wilderness Area, and the Bridger Wilderness Area). If the proposed Gros Ventre Wilderness Area is approved, approximately 2/3 of the study area will be in this Class I area.

Although most pollutants produced will be negligible and degrade air quality only in the immediate vicinity of the drilling rig (with the airshed returning almost immediately to original ambient airshed levels), the effects of NO_x will cover a fairly large area. Is it your opinion that the NO_x concentrations will be significant? Are you aware of any studies done on NO_x effects on flora and fauna in Wyoming? Will an NO_x PSD standard be in effect in the near future?

Also, it is my understanding that Section 14(d) of the Air Quality Regulations will be applicable to diesel drilling engines. How is this provision presently enforced?

Hydrogen sulfide (H_2S) gas has been identified as an impact and concern of the people of Jackson, Wyoming, for the Cache Creek wellsite. A worst possible case (F stability and minimal winds) will be done, using a valley-modified Pasquill-Gifford equation, and this analysis will be presented for your review in the Draft EIS.

Thank you for your cooperation, and for any assistance you can provide.

Sincerely,

Paul Kruger

Paul Kruger
EIS Task Force Member, Cache Creek

PKruger:ma
Encls

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

AIR QUALITY DIVISION

HATHAWAY BUILDING
401 W. 19th St.

CHEYENNE, WYOMING 82002

TELEPHONE 777-7391

August 19, 1980

Mr. Paul Kruger
U.S. Department of Interior
Geological Survey
P.O. Box 1170
Rock Springs, WY 82901

Dear Mr. Kruger:

I have reviewed your letter of July 18, 1980, and offer the following comments regarding interpretation of Wyoming Air Quality Standards and Regulations:

1. Exemption from special permits or Section 24, Prevention of Significant Deterioration.

   First of all, if a facility does not have the potential to emit 250 tons/yr of any air pollutant for which standards are established, the provisions of Section 24 do not apply. Further, if the facility does have the potential to emit 250 tons/yr of a pollutant, the requirements for a demonstration of compliance with Section 24b(1)(a) & (b) can be waived if the emissions would impact no Class I area and no area where an applicable increment is known to be violated; and the emissions are of a temporary nature including those from a portable facility.

   Section 21 of the Standards and Regulations, permit requirements for construction, modification and operation, can be interpreted to require a permit for a facility such as a drilling rig. However, it has not been this Division's policy to date to require a permit for these types of operations.

2. Compliance with PSD Increments.

   Our present interpretation of compliance with allowable increments is that regardless of whether a facility can be classified a "major emitting facility" or not and even if it is temporary, compliance with applicable increments is required.

   In reviewing your summary on modeling efforts, although assuming a ground level source and Class C stability would certainly be a conservative approach, we would likely try to give some credit for stack height and plume rise in dispersion calculations.

3. Would operation at one location 2 to 3 years require permitting, and could it still be considered a temporary source?

   There is no definitive answer to this question. Such circumstances would be reviewed on a case by case basis and since there is no definition of temporary, this becomes a matter of judgement. New revised PSD regulations promulgated by EPA restricts temporary emissions to two years. The State of Wyoming has 9 months from the effective date of August 7, 1980, in which to revise its regulation.

4. Class I Areas.

   A comment with regard to the proposed Gros Ventre Wilderness Area - It should be noted that unless Congress declares this area a Class I area it will not automatically become a Class I area. Any redesignation process excluding action by Congress requires action by the State of Wyoming.

5. NO_x Impact.

   Significant Impact - At over a 100 tons per year for the source, one could not say that the impact would be insignificant. As a guideline, EPA in the June 19, 1978 Federal Register presents a table of significant concentrations. These values, which are generally based on Class I increments, are intended to be used as values beyond which no further modeling is required. For NO_2, EPA suggests that 1 ug/m^3 on an annual average is the minimum level of significance.

   NO_x PSD Standard - We have no idea when a NO_x PSD standard will be in effect. EPA is only beginning preliminary work concerning PSD Set II regulations.

   Effects on Vegetation - I am not aware of any studies done on NO_x effects on flora and fauna in Wyoming.

6. Opacity Limitations, Section 14(d).

   I am not aware of this Section of the Regulation ever being enforced. In any case, enforcement of this standard is not a high priority item among enforcement of the many other regulations that require the full effort of this Division.

If this office can be of further service, please don't hesitate to contact us.

Very truly yours,

Charles A. Collins

Charles A. Collins
Air Quality Supervisor

CAC:ct

Appendix 2

Expected Traffic to Proposed Cache Creek Wellsite

Expected Traffic (from Cache Creek Environmental Assessment)

Type of Traffic	Trips Frequency	Total	Loaded Weight per Vehicle, lbs.
Drilling Traffic:			
Rig crews	3/day	540	6,000
Rig pusher	2/day	360	6,000
Rig mechanic	1/week	25	7,000
NCRA supervisor	2/day	360	4,000
NCRA geologist	2/day	360	4,000
Fuel truck	3/week	75	18,000
Mud truck	1/12 days	15	80,000
Mud engineers	1/day	180	4,000
Drill bit deliveries	2/week	50	18,000
DST trucks	3/well	3	18,000
Casing haulers	9/well	9	80,000
Cementers, pump truck	3/well	3	46,000
, cement truck	6/well	6	90,000
Cementers, engineer's PU	6/well	6	6,000
Loggers, logging truck	2/well	2	40,000
, engineer's car	4/well	4	4,000
Casing crew	3/well	3	17,000
Sprinkler truck	1/day	180	35,000
Miscellaneous supplies	2/week	50	8,000
Welder	2/month	3	17,000
Completion Traffic:			
Completion unit	1/well	1	75,000
equipment truck	1/well	1	20,000
crew pickup	1/day	30	7,000
pusher	3/week	12	6,000
NCRA supervisor	2/day	120	4,000
Tubing truckers	2/well	2	75,000
Service tools	2/week	8	16,000
Loggers, logging truck	1/week	1	40,000
engineer's car	2/week	2	4,000
Anchor installation truck	1/well	1	15,000
testing truck	1/well	1	10,000
Test tank trucking	4/well	4	60,000
Acidizing, pump truck	1/well	1	46,000
, acid truck	1/well	1	40,000
,engineer's car	2/well	2	4,000
Fracing, pump trucks	4/well	4	70,000
, blender	1/well	1	35,000
, chemical trucks	2/well	2	35,000
, sand trucks	2/well	2	90,000
, engineer's car	2/well	2	4,000
Sprinkler truck	1/day	30	35,000
Miscellaneous supplies	2/week	32	8,000
Pumping & tank battery equipment	5/well	5	80,000
Roustabout crew	1/day	30	7,000
Welder	5/well	5	17,000

Appendix 3

Noise Survey Results

NOISE MEASUREMENTS

Cache Creek - Bear Thrust EIS

Drilling Rigs

Equipment: GR 1945 (Serial No. 138)   Date: 10/23/80

Well Name and No: Near Evanston

Rig: MG F 14/01

Engine Description: 3 CAT Diesel Electric

Weather/Surface Conditions: Cold, Clear, Calm

Wellsite (Drill Hole)

L max: 29 * / ——— 2000 feet ——— ↓ ——— 100 feet ——— / L max: 81 *

L eq: 26 * / ——— / L eq: 78 *

all operations — all operations

L max: ________ *

L eq: ________ *

---

* Each run ½ hour

N O I S E M E A S U R E M E N T S

Cache Creek - Bear Thrust EIS

Drilling Rigs

Equipment: GR 1945 (Serial No. 138) Date: 10/23/80

Well Name and No: Woodruff Narrows #1-4H

Rig: Noble #132

Engine Description: 3 GM EMD Diesel Electric

Weather/Surface Conditions: Cold, Clear, Calm

Wellsite (Drill Hole)

L max: 31 * / 2000 feet • 100 feet / L max: 80 *

L eq: 30 * / /L eq: 75 *

all operations all operations

L max: ______ *

L eq: ______ *

* Each run ½ hour

NOISE MEASUREMENTS

Cache Creek - Bear Thrust EIS

Drilling Rigs

Equipment: GR 1945 (Serial No. 138) Date: 10/23/80

Well Name and No: Whitney Canyon #1-30F

Rig: Loffland #30

Engine Description: 3 CAT Diesel Electric

Weather/Surface Conditions: Cold, Clear, Calm

Wellsite (Drill Hole)

L max: 32 * / 2000 feet ↓ 100 feet / L max: 94 *

L eq: 26 / * / L eq: 74 *

all Operations — all Operations

L max: ______ *

L eq: ______ *

* Each run ½ hour

Noise Measurements
Cache Creek-Bear Thrust EIS
Oilfield Access Roads
GR 1945 Noise Analyzer (Serial No. 138)

Place: Bar X road just north of interstate 80 (North of Table Rock, Wyoming)

Type of Vehicles on Road: Light and heavy truck traffic.

Date: 11/24/80 Time: 10:30 AM

Weather and Surface Conditions: Snowing, Snow on ground (1-2 inches)

o 35 dbA @ edge of ditch *

Ditch (approx. 10')

Access Road (16' to 18' running surface)

Ditch (Approx. 10')

o 82 dbA @ 25 feet *

o 30 dbA @ 50 feet *

o 30 dbA @ 100 feet *

* Each run ½ hour, Sound Level is Lmax

Noise Measurements
Cache Creek-Bear Thrust EIS
Oilfield Access Roads
GR 1945 Noise Analyzer (Serial No. 138)

Place: Tri Territory Road 15 miles north of Rock Springs, Wyo.

Type of Vehicles on Road: Light and heavy truck traffic

Date: 11/26/80 Time: 10:00 AM

Weather and Surface Conditions: Sunny, Calm, skiffs of snow on ground.

o /06 dbA @ edge of ditch *

Ditch (approx. 10')

Access Road (16' to 18' running surface)

Ditch (Approx. 10')

o 91 dbA @ 25 feet *

o 28 dbA @ 50 feet *

o 27 dbA @ 100 feet *

* Each run ½ hour, Sound Level is Lmax

Noise Measurements
Cache Creek-Bear Thrust EIS
Oilfield Access Roads
GR 1945 Noise Analyzer (Serial No. 138)

Place: Luman Road 1 mile north of Wamsutter, Wyo.

Type of Vehicles on Road: Heavy truck traffic.

Date: 11/25/80 Time: 10:30 AM

Weather and Surface Conditions: Calm winds, Clear, skiffs of snow

o 104 dbA @ edge of ditch *

Ditch (approx. 10')

Access Road (16' to 18' running surface)

Ditch (Approx. 10')

o 84 dbA @ 25 feet *

o 32 dbA @ 50 feet *

o 28 dbA @ 100 feet *

* Each run ½ hour, Sound Level is Lmax

AMBIENT NOISE MEASUREMENTS

Cache Creek - Bear Thrust EIS

Equipment: GK 1945 (Serial No. 138) Date 11/23/80

Place: Beginning of Gravel Cache Creek Road

Length of Run: 1 hr Begin: 10:00 PM End: 11:00 PM

Reason: Ambient Noise in residential Jackson.

LMAX	L0.1	L1	L10	L50	L90	L99	LEQ	LDN
49	-	-	-	29	-	-	32	-

Comments: Very light traffic in area.

AMBIENT NOISE MEASUREMENTS

Cache Creek - Bear Thrust EIS

Equipment: GK 1945 (Serial No. 138) Date 11/23/80

Place: Near Cache Creek wellsite

Length of Run: 12 hr Begin: 9:00 AM End: 9:00 PM

Reason: Determine Ambient Noise Levels in Cache Creek Area

LMAX	L0.1	L1	L10	L50	L90	L99	LEQ	LDN
42	-	-	-	30	-	-	(29)	-

Comments: Lmax may be wildlife in area or possibly small plane in vicinity. Winds minimal and snow patches on ground.

AMBIENT NOISE MEASUREMENTS

Cache Creek - Bear Thrust EIS

Equipment: GK 1945 (Serial No. 138) Date 11/22/80

Place: about ½ mile north of old mine camp on access to [illegible] Reserve Site

Length of Run: 12 hr Begin: 10:00 AM End: 10:00 PM

Reason: Determine ambient noise levels in [illegible] Thrust Unit

LMAX	L0.1	L1	L10	L50	L90	L99	LEQ	LDN
38	-	-	-	36	-	-	(33)	-

Comments: [illegible] animal with light (2 to 4 inch) snow cover.

A M B I E N T   N O I S E   M E A S U R E M E N T S

Cache Creek - Bear Thrust EIS

Equipment: GK 1945 (Serial No. 138) Date 12/08/80

Place: LaBarge Field (Near LaBarge Wyoming)

Length of Run: 1 hr Begin: 1 PM End: 2 PM

Reason: Noise Levels in developed oil field.

LMAX	L01	L1	L10	L50	L90	L99	LEQ	LDN
68	-	-	-	-	-	-	58	-

Comments:

AMBIENT NOISE MEASUREMENTS

Cache Creek - Bear Thrust EIS

Equipment: GK 1945 (Serial No. 138) Date 12/09/80

Place: Nightingale Compressor Station

Length of Run: 1/2 hr Begin: 12 PM End: 12:30 PM

Reason: Confirm. FERC Compressor Noise Levels.

LMAX	L0.1	L1	L10	L50	L90	L99	LEQ	LDN
44	-	-	-	-	-	-	(35)	-

Comments: Hiway nearby. 1 mile from compressor

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9/11/80

Calm winds, random times of day and temperatures .

Well Name and Number: Woodruff Narrows #1-4H

Rig: Noble # 132

Engines 3GM-EMD 8-645E1 (Diesel-Electric, or Compound)

Character of Terrain: Mountainous

	all operating
Sound Level dbA at front of Engines:	105 dbA
Sound Level dbA 100 feet North:	78
Sound Level dbA 100 feet East:	76
Sound Level dbA 100 feet South:	72
Sound Level dbA 100 feet West:	73
Sound Level dbA at 400 feet North:	69
Sound Level dbA at 400 feet East:	65
Sound Level dbA at 400 feet South:	62
Sound Level dbA at 400 feet West:	60

3 GM - EMD 8-645-E1
S# 78 D1-1034
78 D1-1082
78 D1-1065

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9/11/80

Calm winds, random times of day and temperatures .

Well Name and Number: Near Evanston

Rig: MGF Rig #101

Engines: 3CAT D399 (Diesel, Electric, or Compound)

S/N's 35B4945, 35B4959, 35B4961

Character of Terrain: ridge top area

	all operating
Sound Level dbA at front of Engines:	96 dbA
Sound Level dbA 100 feet North:	78
Sound Level dbA 100 feet East:	74
Sound Level dbA 100 feet South:	73
Sound Level dbA 100 feet West:	72
Sound Level dbA at 400 feet North:	68
Sound Level dbA at 400 feet East:	65
Sound Level dbA at 400 feet South:	68
Sound Level dbA at 400 feet West:	70

<u>SOUND SURVEY</u>

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9/11/80

Calm winds, random times of day and temperatures .

Well Name and Number: Chevron Whitney Canyon #1-30F

Rig: Loffland #30

Engines 3 CAT D-398 (Diesel, Electric, or Compound)

Character of Terrain: Mountain Valley

#2: 66D7346
Arrangement # 3N 1127
#3: 66D6681

		all operations
Sound Level dbA at front of Engines:		103 dbA
Sound Level dbA 100 feet North:		79
Sound Level dbA 100 feet East:		74
Sound Level dbA 100 feet South:		72
Sound Level dbA 100 feet West:		74
Sound Level dbA at 400 feet North:		64
Sound Level dbA at 400 feet East:		60
Sound Level dbA at 400 feet South:		59
Sound Level dbA at 400 feet West:		62

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9/11/80

Calm winds, random times of day and temperatures .

Well Name and Number: Carter Creek #1-18F

Rig: Parker 171

Engines: Waukesha (Diesel, Electric, or Compound)

Character of Terrain: In canyon area

	Idling	Revved
Sound Level dbA at front of Engines:	99 dbA	107 dbA
Sound Level dbA 100 feet North:	75	80
Sound Level dbA 100 feet East:	73	81
Sound Level dbA 100 feet South:	72	79
Sound Level dbA 100 feet West:	74	80
Sound Level dbA at 400 feet North:	68	70
Sound Level dbA at 400 feet East:	64	67
Sound Level dbA at 400 feet South:	61	68
Sound Level dbA at 400 feet West:	61	70

- Note on Compound Rigs - Sound varies due to loading of engines (dependent on operations being done) approximate variation when pulling pipe is ± 7-10 dbA)

<u>SOUND SURVEY</u>

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9/11/80

Calm winds, random times of day and temperatures.

Well Name and Number: Amoco D Champlin 457

Rig: BOMAC #44

Engines: 3 CAT D379 (~~Diesel,~~ Electric, or (Compound))

S/N #68B5025 during #3N/129
" 26
" 27

Character of Terrain: Ridgetop and

Sound Level dbA at front of Engines:	103 idling dbA	106 work dbA
Sound Level dbA 100 feet North:	74	81
Sound Level dbA 100 feet East:	69	78
Sound Level dbA 100 feet South:	72	79
Sound Level dbA 100 feet West:	71	80
Sound Level dbA at 400 feet North:	63	72
Sound Level dbA at 400 feet East:	61	75
Sound Level dbA at 400 feet South:	63	75
Sound Level dbA at 400 feet West:	60	70

Note on Compound Rigs - Sound Varies due to loading (dependant on operation being done) approx. variation of ± 7-10 dbA.

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9-12-80

Calm winds, random times of day and temperatures .

Well Name and Number: Apache #3-23

Rig: Rodren Rig #6

Engines: GM (Diesel, Electric, or Compound)

Character of Terrain: Rolling sagebrush hills

Sound Level dbA at front of Engines:	85 idling	100 travel
Sound Level dbA 100 feet North:	78 "	80 "
Sound Level dbA 100 feet East:	72 "	83 "
Sound Level dbA 100 feet South:	71 "	82 "
Sound Level dbA 100 feet West:	70 "	80 "
Sound Level dbA at 400 feet North:	61 "	73 "
Sound Level dbA at 400 feet East:	60 "	72 "
Sound Level dbA at 400 feet South:	58 "	71 "
Sound Level dbA at 400 feet West:	60 "	70 "

Note: on compound Rigs sound varies due to loading of engines (dependant on operation being done) approx variation of ± 7-10 dbA)

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9-15-80

Calm winds SW, random times of day and temperatures .

Well Name and Number: Woods Rock Canyon #1

Rig: Apollo 4

Engines: (Diesel, Electric, or Compound) — "Diesel, Electric" circled

Character of Terrain: Rolling hills - bluffs

	drilling
Sound Level dbA at front of Engines:	97
Sound Level dbA 100 feet North:	75
Sound Level dbA 100 feet East:	63
Sound Level dbA 100 feet South:	65
Sound Level dbA 100 feet West:	66
Sound Level dbA at 400 feet North:	
Sound Level dbA at 400 feet East:	55
Sound Level dbA at 400 feet South:	
Sound Level dbA at 400 feet West:	

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9-30-80

Calm winds, random times of day and temperatures .

Well Name and Number: Amoco

Rig: GF 102

Engines: Diesel - 8'' (Diesel-Electric or Compound)

Character of Terrain: rolling open country

	All Operating
Sound Level dbA at front of Engines:	110
Sound Level dbA 100 feet North:	72
Sound Level dbA 100 feet East:	74
Sound Level dbA 100 feet South:	73
Sound Level dbA 100 feet West:	72
Sound Level dbA at 400 feet North:	60
Sound Level dbA at 400 feet East:	57
Sound Level dbA at 400 feet South:	55
Sound Level dbA at 400 feet West:	56

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 10-9-80

Calm winds, random times of day and temperatures .

Well Name and Number: ______________________

Rig: [illegible]

Engines: Diesel Electric (Diesel, Electric, or Compound)

Character of Terrain: [illegible]

	all operation
Sound Level dbA at front of Engines:	120
Sound Level dbA 100 feet North:	74
Sound Level dbA 100 feet East:	72
Sound Level dbA 100 feet South:	75
Sound Level dbA 100 feet West:	73
Sound Level dbA at 400 feet North:	52
Sound Level dbA at 400 feet East:	60
Sound Level dbA at 400 feet South:	51
Sound Level dbA at 400 feet West:	51

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 10/15/80

Calm winds, random times of day and temperatures .

Well Name and Number: Goldenrod #1 20-27 109

Rig: Rio Grande #26

Engines: (Diesel, Electric, ~~or~~ Compound)

Character of Terrain: Rolling Plains

	rolling	loaded
Sound Level dbA at front of Engines:	110 dbA	112 dbA
Sound Level dbA 100 feet North:	76	80
Sound Level dbA 100 feet East:	74	79
Sound Level dbA 100 feet South:	72	79
Sound Level dbA 100 feet West:	74	79
Sound Level dbA at 400 feet North:	64	70
Sound Level dbA at 400 feet East:	60	71
Sound Level dbA at 400 feet South:	59	69
Sound Level dbA at 400 feet West:	62	69

- Note on compound rigs sound levels vary by type of operation being performed.

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 10/15/80

Calm winds, random times of day and temperatures .

Well Name and Number: Pomeroy Draw # 1-11 11-24-113

Rig: Anderson-Myers Rig #3

Engines: (Diesel, Electric, or Compound)

Character of Terrain: Rolling Plains

	drilling only
Sound Level dbA at front of Engines:	107 dbA
Sound Level dbA 100 feet North:	80
Sound Level dbA 100 feet East:	74
Sound Level dbA 100 feet South:	74
Sound Level dbA 100 feet West:	74
Sound Level dbA at 400 feet North:	64
Sound Level dbA at 400 feet East:	60
Sound Level dbA at 400 feet South:	59
Sound Level dbA at 400 feet West:	60

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 10/14/80

Calm winds, random times of day and temperatures .

Well Name and Number: Battle Spring #1 23-24-94

Rig: True #9

Engines: (Diesel, Electric, or Compound)

Character of Terrain: Rolling plains

	drilling
Sound Level dbA at front of Engines:	106 dbA
Sound Level dbA 100 feet North:	75
Sound Level dbA 100 feet East:	71
Sound Level dbA 100 feet South:	73
Sound Level dbA 100 feet West:	70
Sound Level dbA at 400 feet North:	58
Sound Level dbA at 400 feet East:	61
Sound Level dbA at 400 feet South:	52
Sound Level dbA at 400 feet West:	54

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 10/16/80

Calm winds, random times of day and temperatures .

Well Name and Number: Prater Mountain Unit #1

Rig: Parker Drilling #163

Engines: (Diesel-Electric, or Compound)

Character of Terrain: Rolling Plains

	all operations
Sound Level dbA at front of Engines:	108 dbA
Sound Level dbA 100 feet North:	74
Sound Level dbA 100 feet East:	74
Sound Level dbA 100 feet South:	72
Sound Level dbA 100 feet West:	73
Sound Level dbA at 400 feet North:	61
Sound Level dbA at 400 feet East:	60
Sound Level dbA at 400 feet South:	59
Sound Level dbA at 400 feet West:	60

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 9/12/80

Calm winds, random times of day and temperatures .

Well Name and Number: Chandler and Associates Spur Creek # 8-2
NW SE Sec 2 - T26N R112W

Rig: Pump Jack

Engines: Natural Gas (~~Diesel, Electric, or Compound~~)

Character of Terrain: rolling sagebrush plains

Sound Level dbA at front of Engines:	85 dbA
Sound Level dbA 100 feet North:	57
Sound Level dbA 100 feet East:	65
Sound Level dbA 100 feet South:	62
Sound Level dbA 100 feet West:	55
Sound Level dbA at 200 feet North:	51
Sound Level dbA at 200 feet East:	52
Sound Level dbA at 200 feet South:	52
Sound Level dbA at 200 feet West:	51

Readings at 400 feet were less than 40 dbA

SOUND SURVEY

General Radio Sound Level Meter - General Radio U.S.A.
Model #1565-B

Date: 8/14/80

Calm winds, random times of day and temperatures .

Well Name and Number: ______

Rig: Brinkerhoff #72

Engines: ______ (Diesel, Electric, or Compound) [Diesel-Electric circled]

Character of Terrain: alpine valley (Granite Creek)

	all operating
Sound Level dbA at front of Engines:	100 dbA
Sound Level dbA 100 feet North:	66
Sound Level dbA 100 feet East:	75
Sound Level dbA 100 feet South:	67
Sound Level dbA 100 feet West:	68
Sound Level dbA at 400 feet North:	58
Sound Level dbA at 400 feet East:	60
Sound Level dbA at 400 feet South:	54
Sound Level dbA at 400 feet West:	59