FROM ENVIRONMENTAL BASELINE STUDIES TO MONITORING, RESEARCH, AND DESIGN

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INTRODUCTION

Thirteen environmental baseline studies were performed at the Occidental Oil Shale, Inc., Logan Wash site in 1974 and 1975. These studies were planned to obtain information (1) to guide the development of a modified in situ oil shale project along environmentally acceptable lines, (2) to provide a basis for detecting any environmental changes that might occur from oil shale activities, and (3) to develop data for permit applications (Ruskin and Phillips 1975). In addition, the studies identified research needed to better define constraints or opportunities for an oil shale facility. This paper describes the studies, resulting activities and shows how results are being used today.

THE OCCIDENTAL OIL SHALE, INC. LOGAN WASH PROJECT

Occidental Oil Shale, Inc. is developing a modified in situ process for producing oil from shale on a 4,325 acre (1,770 ha) parcel in western Colorado. The site is in Garfield County, 51 miles (80.5 km) by road northeast of Grand Junction (fig. 1). It lies north of the Colorado River and U.S. Highways 6 and 24, northeast of the town of DeBeque and southwest of the town of Grand Valley.

The mine and other activities are located at the head of Logan Wash. The property consists of outcrop bounded, more or less, all the way around by gulches up to 2000 feet (600 m) deep. It includes part of Spruce Ridge on the north side of Logan Wash, north of Mount Logan, and includes Mount Callahan.

The Occidental process consists of mining an amount of shale from within the retort configuration, rubblizing the remaining shale to bulk fill the retort, and retorting the rubble in place. An overburden of several hundred feet remains above the rubble.

The amount of material mined is only that necessary to provide mine access and the desired bulk porosity in the rubble. The mined raw shale is the same as natural talus and is placed in selected canyons to resemble talus.

There are only a few mine adits, with benches, over the entire 4325-acre (1,770 ha) property. While each adit can be as large as 24 feet square (51.8 m^2), it is insignificantly small compared to outcrop heights of 2000 feet (600 m). Surface installations, e.g. for oil storage and loading, steam generation, and an exhaust stack and test area, occupy a total of about 30 acres (12 ha).

BASELINE STUDIES

Baseline studies encompass thirteen areas, listed below. As described later, these studies often led to subsequent investigations that form part of the baseline information bank, but which were not part of the initial baseline program.

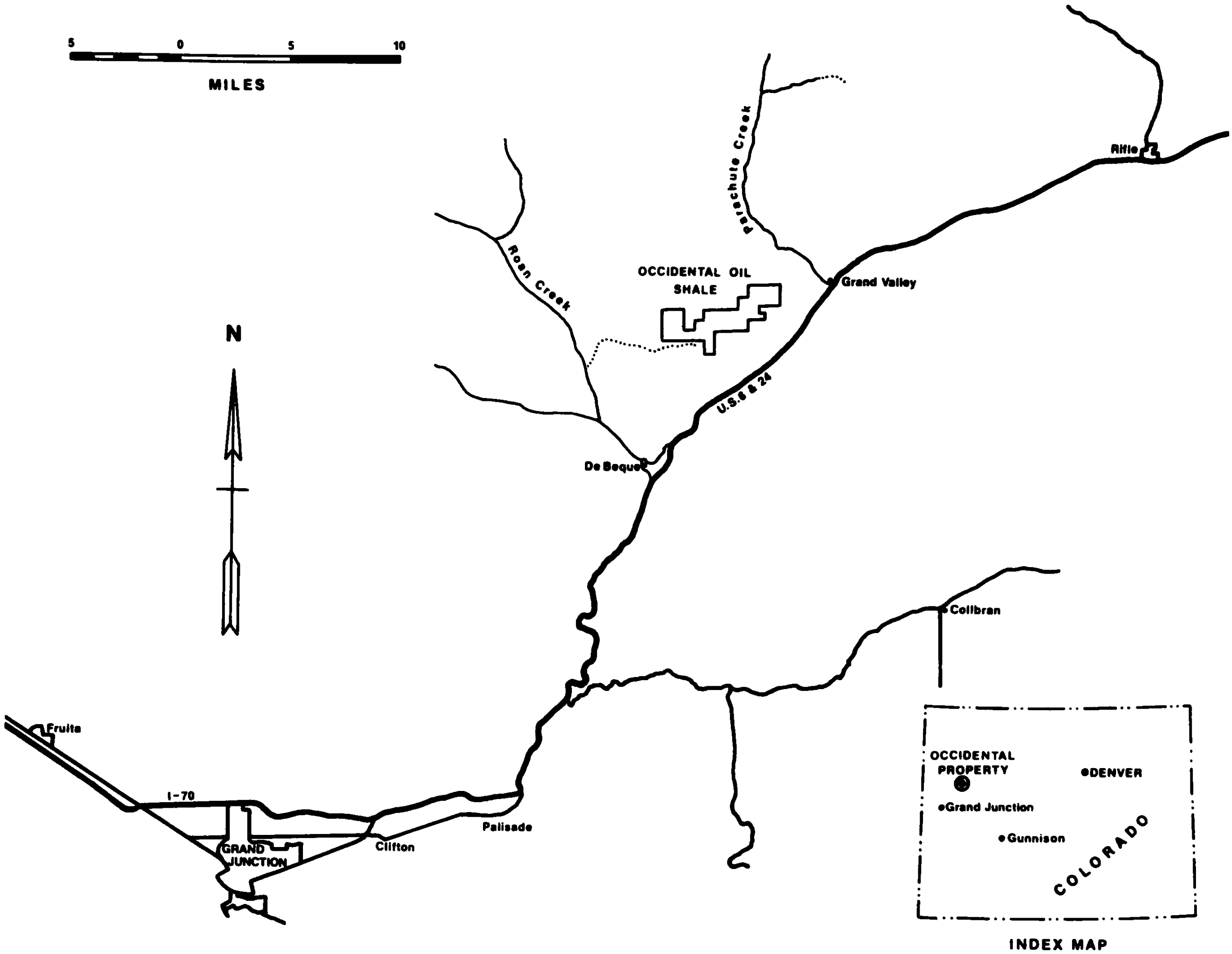

Figure 1. Location map.

Meteorology

Wind speed, direction and temperature, and delta temperature data have been taken continuously since February 1975 on a 100 ft (30 m) tower at the top of the property, i.e. on the plateau. Rawinsonde temperature and wind data were taken every six days for a year to obtain upper air data above the plateau. Relative humidity and precipitation data have also been taken, at the air quality monitoring site. Data collection has been in accord with a program approved by the Air Pollution Control Division, Colorado Department of Health (H.E. Cramer Co., Inc. 1976a and 1976b).

Ambient Air Quality

Ambient concentrations of SO_2, NO_x, hydrocarbons, CO, particulates, and H_2S were measured at a point where a plume from a large-scale operation, if there were one, would be expected to have maximum impact. Pollutants were sampled for 24 hours on a six-day schedule for one year beginning in February 1975, in accord with a program approved by the Air Pollution Control Division, Colorado Department of Health (H.E. Cramer Co., Inc. 1977a).

Surface Water Hydrology

Streams carrying runoff from the property have been studied in terms of flow and water quality. Water quality parameters to be studied were selected in consultation with the Water Quality Control Division, Colorado Department of Health. Precipitation and evaporation have also been measured. One purpose of these measurements is to characterize surface runoff conditions. Another purpose is, together with ground water hydrology data, to develop an overall water balance for the area so that the effects of mine activities can be predicted (Birman and others 1977).

Ground Water Hydrology

Transmissibilities and storage constants were measured via slug and well recovery tests at several locations on the property. Water quality and water level were also measured seasonally at the same test holes. The purpose of these tests was to develop insight into the movement of ground water in the vicinity of the retorts and over the property generally (Birman and others 1977).

Archaeology

The Logan Wash site was surveyed for evidence of archaeological materials and to determine whether proposed developments might affect significant archaeological investigations. In view of the limited usage proposed and the total unsuitability for prehistoric occupation of most of the property, nineteen sub-areas within and adjacent to the property, rather than the entire property, were surveyed (Thomas 1974).

Paleontology

Possible sites for dumping raw shale and two similar sites nearby were surveyed to determine if the proposed dumping would affect significant paleontological investigations (Guthrie 1974).

Flora

Plant density and cover were measured in plots and herbarium vouchers were collected at every quarter section of the property and at some adjacent locations. Soil samples were also taken for taxonomic analysis. Both fall and summer surveys were used because different species bloom at different times and the flowers are sometimes needed to identify the species. The purpose of these studies was to begin identifying the vegetative environment (which varies naturally from year to year) and to determine if there are any rare or endangered species present (West, Irvine, and Loope 1976).

Fauna

Four seasonal surveys were made to determine the major vertebrate species using habitats and water sources on and near the project site. Species composition and relative abundance were determined by visual survey, trapping, and counts of tracts, pellet groups, beds, skeletons, and shed antlers, depending on species and season (Wirtz 1974, 1975a,b,c,d).

Engineering Geology and Soil Engineering

Various possible road and pipeline alignments and power plant sites, etc. were studied to determine if any hazards exist due to geological features. The study included field reconnaissance, background research, and a detailed study of photographs, existing reports, and maps (Leighton and Associates 1976).

Noise

Noise from major underground mine blasting was monitored and compared with current background noise levels in the environs of the Logan Wash project site. The latter were measured seasonally at different times of the day and week. The purpose of this study was to determine the extent to which blasting noise is a significant contributor to the noise level in nearby populated areas, e.g. Grand Valley (Petersen 1975b; Focke 1976).

Seismometry

Ground motion arising from a major underground blast was monitored in Grand Valley, the nearest town, and compared with ground motion arising from railroad and highway traffic in the immediate vicinity. The purpose was to determine if blasting adds significantly to existing vibrations in this populated area (Petersen 1975a).

Subsidence and Uplift

Precise level surveys were made of the surface above the retort area, before retorting, in order to determine any subsidence or uplift that might subsequently occur (Studebaker 1977).

Socioeconomic Impacts

Employee and community data, for the period mid-1972 through 1975, were gathered to determine growth of employee and community populations, community incomes, housing, and community services. Community growth rates and capacity limitations were determined along 19 dimensions. Employees and their families were characterized according to residence, job, job location, age, marital status, and ages of dependents. These data, together with population-to-employment ratios, were used to determine Occidental-derived growth impacts on the communities. This information also provides a basis for projecting further impacts if the project work force is expanded (Lindsey 1976; Ruskin 1977).

These studies were defined basically by people who would use the results. Design personnel and permit granting agencies were interviewed for their needs before the studies were planned. Specialists who would do the field work and analyses were then consulted intensively in preparing detailed scopes of work. Every attempt was made to obtain the greatest possible return of useful data and to conserve funds that might be better used after the first round of baseline investigations.

These specialists made preliminary reconnaissance field trips before preparing detailed scopes. They identified site-specific factors that required special attention. They also identified factors that did not need to be studied because the terrain or other features precluded these factors from being affected by the proposed development. Both theoretical and practical considerations were taken into account in defining the efforts needed to meet the objectives of the baseline study program.

As studies were performed, preliminary findings were transmitted to investigators in related fields and to the ultimate users of the results. Also, new inputs were received from the design personnel and permit-granting agencies as they arose. This practice enabled concurrent and subsequent field studies to be revised and improved and other efforts, e.g. plant design, to be adjusted in light of the findings.

Before moving to a description of how the baseline studies have been used in planning subsequent efforts, it should be noted that the format for the study reports was prescribed to highlight findings, conclusions, and recommendations, as they pertain to the specific project and site. The purpose of the prescription was to make it easy for non-specialist decision-makers to understand the significance of any salient findings and to see as clearly as possible the alternative approaches they might take to any potential problems. Another result of having all the baseline studies in a consistent format is that it facilitated preparing a comprehensive environmental assessment (Ruskin 1976).

USES OF THE BASELINE STUDIES

Baseline study results are presented in the reports cited in the previous section after the study descriptions. It is not the purpose of this paper to reproduce their findings. Rather, this section is devoted to four uses of the studies that go beyond mere descriptions of the environment.

Identification of Needed Research

First, the studies identified four instances that required additional research to resolve. Two of the instances concerned plants and two concerned animals.

The first plant example involved the rediscovery of Festuca dasyclada, a grass thought to be extinct (West and Irvine 1976). Not only was the grass discovered during the baseline investigation, but subsequent research characterized the environment in which it grows. Armed with this information, the investigators identified several other possible sites for the species in Garfield County. Examination of these sites showed the plant to be alive and well and relatively abundant.

The second plant example concerns Douglas fir and aspen trees on the property that were found to be suffering some maladies. Further investigation by a forest entomologist and a forest pathologist showed that the Douglas fir was infested by an insect and that the aspen suffered from canker fungi, aggravated by an insect infestation and rodent feeding (Helburg and Leatherman 1976). The infestation in the Douglas fir has died out and the aspen condition is widespread in Colorado. Conclusion: neither condition was the result of Occidental activities.

The first animal example of needed research concerns the discovery of prairie and peregrine falcons flying over a canyon where Occidental contemplated some mine support activities. A detailed examination was made during the following breeding season to determine if the falcons nested within the canyon or nearby (Redmond and Wirtz 1976). Conclusive evidence was found that the falcons were not nesting in areas at or near the proposed activities.

Baseline investigations also indicated that the local deer herd needed to be studied to determine if an apparent imbalance in the buck-to-doe ratio did, in fact, exist and, if fawn productivity was as low as it first seemed (Wirtz 1974). If either of these apparent anomalies was real, further work would be needed to ascertain the cause. Subsequent studies have shown both the buck-to-doe ratio and fawn productivity to be within normal ranges (Wirtz 1976 and 1978).

Definition of Development Constraints

A second use of the baseline results has been to identify constraints and help define limits for certain activities. Only the flora and fauna studies showed any potentially serious hurdles. As described above, however, subsequent research proved that none of these issues is in fact a barrier to careful development of the Occidental process on the site.

Three studies did indicate the need for care in siting various facilities. The meteorology study indicated that the exhaust stack needs to be on the plateau, i.e. on the top of the property (perhaps an obvious result) (H.E. Cramer Co., Inc. 1976c; 1977b). And, the engineering geology and animal studies indicated that certain road alignments are preferable to others (Leighton and Associates 1976; Wirtz 1975d).

Identification of Development Opportunities

A third use of the baseline results has been to identify some non-obvious but economical ways to minimize environmental impacts on the project. One example is the opportunity to control the intrusion of mine water into a spent retort by properly locating the air level above the retort. Because of the geohydrology of the area (Birman and others 1977), a properly-located air level can serve as a water collection gallery after retorting is concluded. By having the mine drifts slope downhill from the gallery to the outcrop, water that infiltrates into the gallery can escape to the outcrop and circumvent the retort altogether. "Proper location", here, means at an elevation such that the sill pillar between the air level and the retort itself contains tight or impermeable strata.

Another example is the opportunity to optimize the design of an exhaust stack in terms of location, height, construction costs, and pressure drop. Detailed meteorological data, together with exhaust information, have made it possible to design the stack for a nearby "second highest point," instead of a more obvious but more distant and, therefore, more costly "highest point" (H.E. Cramer Co., Inc. 1978b).

A third example is the possibility of controlling dust and evaporating limited amounts of waste water at the same time by spraying with waste water. Evaporation data taken as part of the hydrology study indicated that the amount of water that could be evaporated from the area where dust control is needed is commensurate with the amount of water to be disposed (Birman and others 1977). Thus, baseline data identified an opportunity to meet two objectives with one action.

Definition of Monitoring Programs

A fourth use of baseline studies has been to identify suitable ways of monitoring any impacts the project may have on the environment. The plant and animal baseline studies, for example, were used to select so-called "affected" or "test" areas, and corresponding control areas (West and Irvine 1977; Wirtz 1978). The test areas are communities and habitats near current operations. The control areas are similar settings, a considerable distance from the operations. We can now compare vegetation in each test area with vegetation in the corresponding control areas and, thus, determine if the test area is indeed affected. Similarly for animal populations in test and control areas. So far, no problems concerning plants or animals have been observed.

Both air quality and hydrology monitoring programs have been scoped on the basis of corresponding baseline results. Baseline air programs showed that an uncomplicated approach to air quality monitoring would provide satisfactory measurements (H.E. Cramer Co., Inc. 1978a).

The baseline hydrology program showed that two of the five major drainages would not be affected by current operations and need not be monitored (Schick and Birman 1978). The baseline work also showed, however, that the alluvial levels in the remaining drainages should be monitored in order to assess subsurface runoff, which turns out to be a not insignificant part of total runoff.

CONCLUSION

Environmental work at Logan Wash has changed, in the last four years, from exploratory reconnaissance to baseline inventories to monitoring programs. Along the way, the information has been used to plan very specific, detailed investigations; to define development constraints and identify opportunities; and to prepare permit applications and an environmental impact assessment. The environmental program has not been static, but rather has been increased in some areas and decreased in others, in keeping with the need for environmental information by the rest of the project. The aim throughout has been to develop information that can serve as the basis for orderly and environmentally acceptable development of the Occidental process.

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