POST-EVENT
BIOENVIRONMENTAL SAFETY ASPECTS
PROJECT RULISON

by

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HISTORICAL DESCRIPTION

Project Rulison is a joint experiment sponsored by Austral Oil Company, Inc., Houston, Texas, the U. S. Atomic Energy Commission, and the Department of the Interior, with the Program Management provided by CER Geonuclear Corporation of Las Vegas, Nevada, under contract to Austral. Its purpose is to study the economic and technical feasibility of using underground nuclear explosions to stimulate production of natural gas from the low productivity, gas-bearing Mesaverde formation in the Rulison Field.

The nuclear explosive for Project Rulison was detonated successfully at 3:00 p.m. plus 0.1 seconds Mountain Daylight Time, September 10, 1969, at a depth of 8,425.5 feet below ground level and was completely contained. Preliminary results indicate that the Rulison device behaved about as expected; i. e., with a yield of $40 \pm 20_4$ kt. The wellhead of the emplacement well, Hayward 25-95A, is at an elevation of 8,154 feet above mean sea level (MSL) and is located 1,976.31 feet east of west line and 1,813.19 feet north of south line of Section 25, Township 7 south, Range 95 west of 6th p.m., Garfield County, Colorado, which corresponds to geodetic coordinates of longitude $107^\circ, 56', 53''$ west and latitude $39^\circ, 24', 21''$ north.

PRE-EVENT SURVEY AND EVALUATION

Approximately six months prior to detonation of the Project Rulison nuclear device, an ecological survey was made of the area around the drill site. The primary objectives of the survey were to ascertain the seasonal distribution of range livestock and wild game in the area, and the distribution and use of water from the Battlement Creek watershed in which the site is located. This information was needed to plan protective measures in the event of an accidental release of radionuclides to the environment at the time of the detonation, although AEC safety evaluations concluded that such a

release was very unlikely. The survey was also directed to identifying any potential adverse ecological effects from site operations, or from the detonation, for which preventive or remedial action might be needed.

The pre-event survey recognized the importance of range livestock production and big-game hunting in the immediate environs of the project site. It was therefore recommended that if containment should not be achieved, as indicated by on-site radiological monitoring, edible products from local range cattle and game animals should be checked for radionuclide burdens to assure acceptability of such products for human consumption.

The only significant potential problem identified during the pre-event survey was the possibility of pollution of Battlement Creek with such contaminants as oil, drilling muds, and drill cuttings remaining at the drill site after completion of the device-emplacement hole. The drill site is located a little over 100 feet from the East Fork of Battlement Creek. When the survey was started, large quantities of these drilling wastes were still present at the site, contained in earth-walled sump pits adjacent to the East Fork.

Battlement Creek is an important source of water for domestic use, stock watering, and irrigation. It is also a trout stream fished by local residents. The potential threat of stream pollution was therefore stressed in the pre-event report.*

The report recommended that adequate predetonation precautions be taken to prevent pollution of the creek. A plan for water sampling and water-quality analyses to monitor the effectiveness of the precautionary measures was also outlined.

POST-DETONATION EVALUATION

On-site radiological surveillance conducted by other AEC contractors indicated that the detonation was accomplished without release of radioactivity to the environment. Therefore, assessment of radionuclide burdens in game animals and range livestock in the area was not considered necessary.

Before the nuclear explosive was emplaced and detonated, most of the oil and drilling wastes were removed from the mud sumps nearest the emplacement hole and hauled away from the site. These sumps were filled

*Fuller, R. G., 1969. Pre-event bioenvironmental safety survey and evaluation, Project Rulison, U. S. AEC Rept. PNE-R-3.

and leveled. The small remaining amount of oil and drilling effluent was contained behind a large dike constructed several hundred feet from Ground Zero (GZ). Dr. R. S. Davidson, of Battelle's Columbus Laboratories, visited the site nine days after the detonation and reported that there was no evidence of escape of this remaining material into Battlement Creek.

A pre- and post-detonation water sampling and water-quality analysis program was carried out by the Colorado Department of Health in accord with the recommended sampling plan. Samples were collected from the following locations:

- (1) East Battlement Creek upstream from GZ, completely above site activity
- (2) East Battlement Creek downstream from the lowest settling pond
- (3) Main Battlement Creek, between 2.0 and 2.5 miles below GZ.

Samples were taken from these three locations on September 3, 1969 (one week before the detonation) and on September 11 (approximately 24 hours after the detonation). Samples were also collected from Locations (1) and (3) on September 18, eight days after the detonation. The Colorado Department of Health carried out standard water-quality analyses and measurements of gross alpha and beta radioactivity on the samples. Alpha and beta counts were reported to be "undistinguishable from background" for all of the samples. The water-quality analyses showed that, for all three sampling locations, creek-water samples collected one day after the Rulison detonation were considerably more turbid and darker colored than comparable samples taken one week before the detonation. Samples taken eight days post-detonation had turbidity and color values that were almost back to predetonation levels. The values reported are tabulated below.

Pre- and post-detonation creek-water samples did not differ to any significant extent with respect to any of the other water qualities measured (total hardness, calcium, magnesium, specific conductance, etc.) in the standard analyses.

It is reasonable to think that ground motion from detonation of the Rulison nuclear device was at least partially responsible for the observed transient increase in turbidity and color of Battlement Creek water at all three sampling locations. Shot-generated ground movement would have been expected to disturb stream-bed sediments and possibly to cause earth slides into the stream channels. Another significant factor also may have been the rain and hailstorm that occurred over the Battlement Creek watershed about 2 hours after the detonation. The rain and hail would have increased stream

flow and increased the silt loading in the streams, raising turbidity and color values in creek water samples. It is not feasible, on the basis of available information, to estimate the relative importance of the detonation and the storm in temporarily increasing the turbidity of Battlement Creek water. In any event, the effect was transient and did not prevent normal use of the water.

Values Found for Indicated Sampling Locations, Dates (1969), and Times of Day									
Water Quality	Location 1			Location 2			Location 3		
	E Battlement Creek			E. Battlement Creek			Main Battlement		
	above GZ			below GZ			Creek, 2-2.5 mi		
	9/3	9/11	9/18	9/3	9/11	9/18	9/3	9/11	9/18
	1530	1400	--(a)	1440	1430	--(a)	1510	1445	1150
	hr	hr		hr	hr		hr	hr	hr
Turbidity ^(b)	2.6	49	6.8	2.5	12.9	--(c)	2 3	39	8.5
Color (cobalt scale) ^(b)	10	70	--(d)	10	45	--(c)	5	60	--(d)

(a) Time not recorded.

(b) American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1967. Standard methods for the examination of water and waste water. 12th ed. American Public Health Association, Inc., New York. 769 pp.

(c) Not sampled.

(d) Not reported.

Entry of oil and other drilling wastes into the stream was apparently effectively prevented, as judged by examination of the holding dike a few days after the detonation. However, it should be noted that the AEC Claims Office received a complaint from one user of Battlement Creek water, who filled a domestic cistern with water from an irrigation ditch one or two days after the detonation. The water was reported to have an oily surface film and to contain "black silt". The United States Geological Survey, Denver, Colorado, collected water samples on September 19, 1969, from the cistern, the irrigation ditch, and a kitchen tap supplied from the cistern. Analyses for turbidity and color gave relatively low values; a test for oil and grease, based on wet extraction with diethyl ether, showed 4 ppm extractables in all three samples. The source of this material was not determined, and there is insufficient evidence to show whether or not the traces of oily contaminant found in the samples were derived from the Rulison operation.

On September 3, 1969, the NVOO Test Manager's Office asked the Colorado Department of Game, Fish, and Parks (Northwest Regional Office, Grand Junction, Colorado) to make pre- and post-Rulison fish surveys in

Battlement Creek, to document any effects the detonation might have on fish populations in the stream. The Department responded to this request by sending a survey crew to the site the same day.

The water level in East Fork of Battlement Creek was so low that a fish-population survey in that stream was not feasible. Electrofishing of a 300-foot section of Main Battlement Creek just below its junction with East Fork yielded only 7 fish: 4 rainbow trout averaging about 10 inches in length, and 3 cutthroat trout 4 to 6 inches long.

In view of the small size of the sample found in the pre-event survey, Department biologists did not consider that a post-event survey would yield enough information to justify the effort. Judging by the slight effect of the shot on water quality, as described above, there is no good reason to believe that fish populations were affected.

CONCLUSIONS

Effects of the Rulison detonation on the surrounding ecosystem were minimal, and no significant adverse effects were noted during the post-event observations. There was a temporary increase in turbidity and water color in Battlement Creek water immediately after the detonation, although this was at least partly caused by a local rain and hailstorm. In any case, the increase in turbidity was transient, and caused no significant problems for water users. Pre-event measures taken to prevent entry of oil and other drilling wastes into the watershed were apparently effective.

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