is rendered harmless only if it is mixed completely with ventilation flow. Firedamp may accumulate in cavities and build up to large accumulations. A thin roof layer my act as a fuse in spreading the explosion from one region of accumulated methane to another. A weak explosion may intensify as it propagates by rapidly moving accumulated firedamp with air ahead of the flame front. Current studies by the Bureau of Mines are providing information on flame speeds and turbulence characteristics of burning layers of fuel.

Float coal dust can form dangerous clouds even when it is dispersed by a weak explosion or aerodynamic disturbance. A strong disturbance in a properly rock-dusted mine will usually disperse both coal and rock dust in the air, and such a mixture will be nonflammable. But when the aerodynamic disturbance is weak, only the most recently deposited layer, which is usually float coal dust, may be lifted off. The dispersal of a $\frac{1}{32}$-inch layer of coal dust is enough to make a flammable cloud in a typical mine entry. Studies are now under way to elucidate the basic steps by which this skimming process occurs and the dust clouds are formed. This information is needed to develop practical means of combatting the float coal dust hazard.

A third problem arises from the possibility that coal dust and methane may supplement each other in an explosion. Current practices call for increasing the percentage of noncombustible dust by one percent for each 10th of a percent of methane in a mine atmosphere. There is reason to be concerned whether this practice adequately evaluates the equivalence between coal dust and methane from the point of view of explosion hazard. Equivalences have been evaluated for ignition and for marginal combustion; currently, equivalences are being determined for steady-state flame propagation. These investigations should substantiate the adequacy of existing practices or define necessary preventive measures.

In still another approach to reducing explosions and fires in mines the Bureau is seeking means of suppressing explosions at the moment of ignition. This includes adaptation for mine use of industrial explosion suppression systems and commercially available foams. In addition, studies have led to permissible explosives of reduced incendivity, and means of further reducing incendivity are being explored. Ways of improving ventilation of the working "faces" from which coal is extracted are progressing. The possibility of draining methane from coal beds in advance of mining also is being investigated, with a view to predicting methane concentrations and establishing the geological conditions and physical properties of coal that contribute to methane being retained. Developments in high-speed excavation (Project Badger) may possibly be applied to extinguishment of culm bank fires, where the problem is bringing water to deep-seated burning sites.

Projected costs

The value of reducing fatal explosions and fires cannot, of course, be measured in dollars only, but the dollars are impressive. Through fiscal year 1966, 160 mine fires were extinguished, saving more than 545 million tons of coal at a cost of approximately one cent of Federal funds per ton. Other contributions to protecting the Nation's forests and watersheds increase the value of the effort. Finally, numerous estimates have been made of the economic losses due to air pollution. In many of the coal-producing areas, fires in mines and culm banks are a major source of dangerous pollutants.

Brief Descriptions of Additional Programs for Improvement and Preservation of Environmental Values

ECOLOGICAL RESEARCH AND SURVEYS

Man depends on plants and animals directly for food and fiber and for recreation and aesthetic gratification. Man depends somewhat less directly on living organisms for a whole range of services which he cannot otherwise meet, including capture and storage of the sun's energy by plants, replenishment of oxygen in the air, nutrient and other mineral cycling through breakdown of organic tissues into simple chemical compounds again available for use, and a host of other services and functions.

The living organisms that perform these functions occur in communities, the members of which are determined by their ability to tolerate the conditions of the site and interactions with the other members of the community. Their tolerance levels are not necessarily identical, but they overlap in the range of con-