Federal Weather Modification Projects: Compensating The Landowner

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The Southwest is running out of water. Groundwater supplies are dangerously depleted. Demands on surface water far outstrip the supply. It is predicted that the Colorado River Basin, the major supplier of water to several western states, will face severe shortages within two decades.[1] Congress recognized this situation more than fifteen years ago when it charged the Secretary of the Interior with responsibility for developing water resources in the Colorado River Basin.[2]

On March 25, 1981, the House Subcommittee on Water and Power held a hearing to assess the Secretary's progress.[3] The Subcommittee concluded that the greatest potential for augmenting the flow of the Colorado River lay in using weather modification[4] to increase precipitation in the

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1. DIVISION OF ATMOSPHERIC RESOURCES RESEARCH, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, CREST ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT 1 (April 13, 1982) [hereinafter cited as CREST ENVIRONMENTAL ASSESSMENT]. Several factors have contributed to this predicament. Primary among them are: 1) unprecedented population increases caused by the "sunbelt phenomena" and the concurrent increased demand for hydroelectric power; 2) the completion of major water projects, especially the Central Arizona Project; 3) the growth of industry and the expansion of irrigation; 4) the ever-present possibility of major development of coal, petroleum, and shale oil resources and, 5) America's legal obligation to supply water to Mexico. *Id.*

2. Colorado River Basin Project Act, Pub. L. 90-537, Tit. I, § 102, 82 stat. 886, 1968; now codified at 43 U.S.C. § 1501(a) (1984). The Colorado River Basin Project Act of 1968 directed the Secretary of the Interior to prepare a plan to augment current river basin supplies "to meet the future water needs of the Western United States." *Id.* at § 1511. It further declared that the first obligation of any water augmentation project would be satisfaction of the requirements of the Mexican Water Treaty. *Id.* at § 1512. Several years later, Congress additionally directed the Secretary to prepare a plan to improve the quality of Colorado River water. 43 U.S.C. § 1571(a) (1974).

3. DIVISION OF ATMOSPHERIC RESOURCES RESEARCH, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, CREST PROGRAM PLAN 10 (April 15, 1983) [hereinafter cited as CREST PROGRAM PLAN].

4. "Weather Modification" refers to various scientific techniques whereby clouds can be made to produce more precipitation, clouds and fog can be made to disperse, hurricanes can be made to change their course, and hail can be suppressed. *See generally* L. BATTAN, HARVESTING THE CLOUDS: ADVANCES IN WEATHER MODIFICATION (1969). As used in this Note, the term generally refers to the precipitation enhancement technique of "cloud seeding." For rain or snow to fall from a cloud, certain quantities of nuclei must be present. When they are not present in sufficient quantities, they can be introduced artificially by seeding the cloud with microscopic particles. *Id.* at 51. The most commonly used cloud-seeding agent is silver iodide. ATMOSPHERIC PROGRAMS OFFICE, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., U.S. DEP'T OF COMMERCE,

river's drainage basin.[5] Out of the Subcommittee's findings emerged the Colorado River Enhanced Snowpack Test (CREST). CREST is a proposal by the United States Department of the Interior to demonstrate and quantify the potential of augmenting Colorado River water by seeding mountain storms during winter to increase snowpack and the resulting runoff.[6] If Congress authorizes CREST and it subsequently proves successful, it will be followed by a basin-wide operational program of indefinite duration.[7]

The Colorado River derives most of its water from mountain snowpack.[8] By increasing snowpack up to fifteen percent,[9] the Bureau of Reclamation estimates that CREST will increase the flow of the Colorado River by 410,000 acre-feet[10] per year.[11] This added stream flow will increase hydroelectric energy production by 260,000,000 kilowatt-hours.[12] Additionally, because water from snowmelt is generally high quality, the overall salinity level of the Colorado River will decrease significantly.[13]

Along with increased water and power, however, come increased risks of avalanches, floods, and structural damage.[14] Using CREST as an example, this Note explores the problems that exist for landowners who seek compensation for injuries resulting from governmental cloud seeding. Following a brief history of weather modification, this Note describes some of the scientific uncertainties surrounding the field, and how those uncertainties make the plaintiff's burden of proof virtually unbearable. The applicability of trespass and nuisance tort theories are explored, followed by a discussion of governmental defenses. This Note then examines the applicability of the law of eminent domain to governmental cloud seeding. Finally, several proposals are offered to ease the claimant's burden and raise the funds necessary to compensate injured parties.

SUMMARY OF WEATHER MODIFICATION ACTIVITIES REPORTED IN 1981 7 (May 1982) [hereinafter cited as SUMMARY OF WEATHER MODIFICATION ACTIVITIES].

5. CREST PROGRAM PLAN, *supra* note 3, at 10.

6. *Id.* at 1.

7. *Id.* at 5.

8. *Id.* at 15.

9. *Id.* at 1. *See also* DIVISION OF ATMOSPHERIC RESOURCES RESEARCH, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, A COMPARISON OF THE POTENTIAL OF CLOUD SEEDING TO ENHANCE MOUNTAIN SNOWPACK IN COLORADO DURING DRY, NORMAL, AND WET WINTERS 42, 43 (January 1983).

10. An acre-foot of water is the volume of water which would cover an acre of land to the depth of one foot, or 325,851 gallons.

11. CREST PROGRAM PLAN, *supra* note 3, at 19. The Bureau estimates streamflow augmentation of 340,000 acre-feet in the Colorado River Basin and 70,000 acre-feet in the Rio Grande River Basin. The estimate is based on random cloud seeding conducted in the San Juan Mountains and White River Plateau. *Id.*

12. *Id.* at 20. This figure is based on estimates that 340,000 acre-feet of water will reach reservoirs where it can generate additional hydro-electric power. *Id.*

13. *Id.* It is estimated that dissolved solids at Imperial Dam could be reduced by 13 milligrams per liter annually. *Id. See generally* COLORADO RIVER WATER QUALITY OFFICE, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, A PRELIMINARY EVALUATION OF THE ONGOING SALINITY CONTROL AND RELATED PROGRAMS IN THE COLORADO RIVER BASIN (May 2, 1983).

14. *See infra* notes 36-39 and accompanying text.

I. HISTORY OF WEATHER MODIFICATION

Between 1973 and 1981 there were 670 reported weather modification projects in the United States.[15] Human desire to change the weather, either to make it more beneficial or less destructive, is not a strictly modern phenomenon. For centuries people have chanted, prayed, danced, and performed animal sacrifices in an attempt to influence the weather.[16] The Greeks and Romans shot arrows into on-coming storms.[17] Others lit giant bonfires in the belief that they could generate updrafts sufficient to support rain-producing cumulous clouds.[18] Weather modifiers of eighteenth and nineteenth centuries rang churchbells and fired cannons in the hope that such loud noises would suppress damaging hail.[19]

The modern technique of cloud seeding began in 1946, when Vincent J. Schaeffer produced a tiny snowstorm by dropping dry ice into a deep-freeze box.[20] He subsequently dropped dry ice into thin stratus clouds, and dissipation of the cloud was clearly visible from the ground.[21] Bernard Vonnegut demonstrated that silver iodide produced the same effect.[22]

II. SCIENTIFIC UNCERTAINTIES OF WEATHER MODIFICATION

> If we were to ask ourselves where we stand today in the development of weather modification technology, there could be little doubt that in most instances we are still in the Kitty Hawk era.[23]

The field of weather modification is clouded with uncertainties. As one commentator wrote, "pinning down those uncertainties is much like shoveling smoke."[24] Despite satellites, computers, and technical wizardry,

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15. SUMMARY OF WEATHER MODIFICATION ACTIVITIES, *supra* note 4, at 14. The total area affected varied from 270,690 square miles in 1977, to 81,986 square miles in 1981. *Id.* Although most of these projects were attempts to increase precipitation, some were designed to alleviate hail or dissipate fog. *Id.* at 6.

16. W.A. Thomas, *Scientific, Technological, Legal, and Political Uncertainties of Weather Modification*, in WEATHER MODIFICATION TECHNOLOGY AND LAW 2 (R.J. Davis and L.O. Grant ed. 1978).

17. *Id.*

18. *Id.* at 3.

19. L. BATTAN, *supra* note 4, at 17. The widespread practice of firing guns and cannons into advancing hail storms caused such violent disputes between those who shot the guns and those on whose lands the hail fell that, in 1750, Archduchess Maria Theresa of Austria found it necessary to ban the practice. *Id.* at 18. Finally, in 1902, an international conference was called to study the effectiveness of cannon firing on hail suppression. The studies revealed no positive results and the practice was thereafter widely abandoned. *Id.* at 19.

20. *Id.* at 63.

21. *Id.* at 64, 65.

22. *Id.* at 65, 66. Today, silver iodide is the most commonly used cloud seeding agent. SUMMARY OF WEATHER MODIFICATION ACTIVITIES, *supra* note 4, at 7. There are several methods for implanting a cloud with silver iodide. In one method, airplanes drop the seeding agent directly into the active area of a cloud. A second method uses ground-based generators to release a smoke of silver iodide crystals which are carried by air currents near the ground into the cloud. *Id.* Finally, silver iodide can be injected directly into the cloud by artillery shells, rockets, or cannisters of pyrotechnics. L.G. Davis, *Operational Weather Modification Prospects*, in WEATHER MODIFICATION TECHNOLOGY AND LAW 12 (R.J. Davis and L.O. Grant ed. 1978).

23. G. Foote, *Weather Modification: A Technology in Its Infancy*, in WEATHER MODIFICATION TECHNOLOGY AND LAW 92 (R.J. Davis and L.O. Grant ed. 1978).

24. J.W. Kirby, *Judicial Regulation of Weather Modification*, in WEATHER MODIFICATION TECHNOLOGY AND LAW 57 (R.J. Davis and L.O. Grant ed. 1978).

it is impossible to predict exactly how much rain will fall in a given area at a given time, even under normal, unmodified conditions.[25] The best science can offer to date is a fairly reliable prediction that it will or will not rain.[26] The effects of weather modification are even more uncertain. What is known is that some clouds can be modified sometimes, and that sometimes those clouds will produce more snow or rain than they would have otherwise.[27]

One problem lies in the variable nature of clouds. Because it is impossible to predict exactly how much precipitation a given cloud would produce in the absence of seeding, it is equally impossible to measure the effect of seeding.[28] By the same token, because no two clouds are alike in their precipitation potential, it is impossible to obtain accurate comparative data by seeding one cloud and leaving another alone.[29] Determining "normal" precipitation for purposes of comparing it to "enhanced" precipitation is another problem. In Tucson, Arizona, for example, rainfall in August has varied from .08 inches in 1924 to 5.61 inches in 1935.[30] This makes "normal" rainfall during the month of August approximately 2.11 inches, even if Tucson never experienced exactly 2.11 inches during any August.[31] If scientists were to seed the clouds above Tucson next August and total rainfall that month reached 2.5 inches, they could claim that "normal" rainfall was exceeded by four-tenths of an inch.[32] Given the fact that rainfall as low a .08 inches has been recorded during August however, the seeding may be regarded as having increased precipitation by almost two inches. On the other hand, because records reflect rainfall as high as 5.61 inches during August, it is possible to conclude that the seeding decreased precipitation by some three inches.

Largely because of these uncertainties, experimental cloud seeding has at times yielded unexpected results, such as producing a decrease in precipitation when an increase was intended.[33] This is especially true of experiments performed during the summer months. Seeding mountain storms during winter to increase snowpack, however, has met with more success.[34]

Because CREST, if authorized, will be the longest-term, most comprehensive snow-enhancement project to date,[35] its exact effect on precipi-

25. *See* L. BATTAN, *supra* note 4, at 14-15.
26. *Id.*
27. *Id.* at 135.
28. G. Foote, *supra* note 23, at 86.
29. *See id.*
30. L. BATTAN, *supra* note 4, at 75.
31. *Id.*
32. *Id.*
33. When clouds above the Santa Catalina Mountains near Tucson were seeded over seven summers beginning in 1957, for example, a net decrease in precipitation resulted. *Id.* at 79.
34. The Advisory Committee on Weather Control, appointed by President Eisenhower in 1953, found statistically observable increases in snowfall of ten to fifteen percent. *Id.* at 80, 81. Recent studies conducted in Colorado verify these results. G. Foote, *supra* note 23 at 86. However, decreases in snow resulting from winter seeding have also been reported. These occur most often when cloud-top temperatures are very cold or mountain ranges are very narrow. *Id.* at 92.
35. Telephone interview with Edward R. Harris, Environmental Officer, Division of Atmospheric Resources Research, Bureau of Reclamation, Department of the Interior (August 22, 1984).

tation or property is unknown. Emphasizing the potential benefits of the project, the CREST Program Plan merely glosses over the project's potential for causing harm. Yet a long-term snow-enhancement project such as CREST can injure landowners in a variety of ways. Heavy accumulations of snow can result in structural damage or adversely affect power, telephone, water, and sewer lines.[36] Augmented spring runoff can cause severe flooding downstream.[37] The frequency of avalanches can increase.[38] Increased snowfall can also cause socio-economic loss, such as loss of work time and tourism due to poor traveling conditions, increased snow removal costs for municipalities, and the increased likelihood of illness and accidental injury.[39]

Just as there are no assurances that the benefits actually realized from CREST will equal those predicted, there are no assurances that CREST will not cause substantial harm to landowners. The need for a mechanism to adequately compensate those injured by weather modification is considered one of "[t]he principal barriers to the widespread adoption of precipitation management."[40] If the full potential of weather modification is to be realized, large-scale demonstration projects such as CREST are needed. In the meantime, the public should be compensated for any damage which results. The CREST proposal contains no compensation provision, leaving the injured instead to pursue traditional remedies.[41] This pursuit will be substantially hindered by the burden placed on the injured to prove causation.

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36. THE SIERRA ECOLOGY PROJECT, VOLUME V: AN OVERVIEW OF SOCIETAL AND ENVIRONMENTAL RESPONSES TO WEATHER MODIFICATION 44 (1980) [hereinafter cited as SIERRA ECOLOGY PROJECT, VOLUME V].

37. *Id.* at 8. The damaging results of such flooding were brought home to Arizonans in 1983 when the combination of unusually heavy spring snows in the Colorado Mountains and sudden high summer temperatures caused flooding along the Colorado River. Affecting areas as far south as Mexico, the floods caused an estimated 12.2 million dollars of damage. *Somber Prelude to the Fourth*, TIME MAG., July 11, 1983, at 14. Neither the Bureau of Reclamation nor the National Weather Service had anticipated or planned for such an occurrence. *See generally*, Arizona Daily Star, Sept. 11, 1983, at D9, col. 1-2. During the flooding, coincidentally, the CREST proposal came before the Arizona Power Authority Commission. One Commissioner described the response: "We just noticed it and laughed, the timing was so incredibly bad." Arizona Daily Star, July 10, 1983, at D2, col. 4. For more detailed information on the Colorado River flooding and its causes see *Oversight Hearings Before the Committee on Interior and Insular Affairs, House of Representatives, on Colorado River Management*, 98th Cong., 1st Sess. (1983).

38. SIERRA ECOLOGY PROJECT, VOLUME V, *supra* note 36, at 12-14. In addition to causing several deaths per year, avalanches in the Rocky Mountains cause tremendous erosion, transplanting debris from one area to another. *Id.* at 12.

39. A discussion of the socio-economic effects of weather modification is beyond the scope of this Note. For detailed information regarding this subject *see id.* at 38-54.

40. DIVISION OF ATMOSPHERIC WATER RESOURCES MANAGEMENT, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, AN OVERVIEW OF THE SKYWATER IX CONFERENCE ON PRECIPITATION MANAGEMENT AND THE ENVIRONMENT 12 (Sept. 1977) [hereinafter cited as AN OVERVIEW]. *See also* 4 WATERS AND WATER RIGHTS § 357 at 479. (R.E. Clark ed. 1976).

41. Telephone interview with Edward R. Harris, Environmental Officer, Division of Atmospheric Resources Research, Bureau of Reclamation, Department of the Interior (August 27, 1984). Mr. Harris stated that the lack of a compensation provision was due to the Department's belief that existing tort law would adequately redress claimants. He further stated that, until the potential of the CREST program had been adequately demonstrated, establishment of a compensation provision was premature.

III. TORT THEORIES OF LIABILITY

Commentators analyzing the legal ramifications of weather modification focus almost exclusively on the law of torts. Little precedent exists, however, as relatively few weather modification cases have been litigated to date.[42] In only one of those cases did the plaintiff recover.[43]

A. *Proving Causation*

To maintain an action for damages under the principles of tort law, a plaintiff landowner must convince the court that the defendant's weather modification activities were a substantial factor in causing the harm alleged.[44] With only one exception,[45] plaintiffs to date have been unsuccessful in bearing that burden.[46] Given the myriad of uncertainties surrounding knowledge of weather generally, and weather modification

42. Following are most, if not all, of the cases litigated on the subject of weather modification: Lunsford v. United States, 570 F.2d 221 (8th Cir. 1977); Montana Wilderness Ass'n. v. Hodel, 380 F.Supp. 879 (D. Mont. 1974); Weather Engineering Corp. of America v. United States, No. 343-72 (Ct. Cl. 1972); Adams v. California, No. 10112 (Super. Ct., Sutter County, Cal., Apr. 6, 1964); Atmospherics, Inc. v. Ten Eyck, Civ. A (D. Ct. Alamosa County, Colo., Apr. 4, 1973); Shawcroft v. Dep't Nat. Resources, Civ. A (D. Ct. Alamosa County, Colo., Sept. 20, 1972); Reinbold v. Sumner Farmers, Inc. No. 2734-C (Cir. Ct. Tuscola County, Mich., 1974); Summerville v. North Platte Valley Weather Control Dist., 170 Neb. 46, 101 N.W.2d 748 (1960); Slutsky v. City of New York, 197 Misc. 730, 97 N.Y.S.2d 238 (1950); Saba v. Weather Modification, Inc., 307 N.W.2d 590 (N.D. 1981); Samples v. Irving P. Krick, Inc., Nos. 6212, 6223 and 6224 (W.D. Okla., Dec. 22, 1954); Pennsylvania Natural Weather Ass'n. v. Blue Ridge Weather Modification Ass'n., 44 Pa.D. & C.2d 749 (C.P. Fulton County, Pa., Feb. 28, 1968); Township of Ayr v. Fulk, No. 53 (C.P. Fulton County, Pa., Feb. 28, 1968); Farmers and Ranchers for Natural Weather v. Atmospherics, Inc., Civ. No. 7594 (D. Ct. Lamb County, Tex., May 3, 1974); Southwest Weather Research, Inc. v. Rounsaville, 320 S.W.2d 211 (Tex. App. 1958), and Southwest Weather Research, Inc. v. Duncan, 319 S.W.2d 940 (Tex. App. 1958), *both aff'd sub nom.*, Southwest Weather Research, Inc. v. Jones, 160 Tex. 104, 327 S.W.2d 417 (1959); Auvil Orchard Co. v. Weather Modification, Inc., No. 19268 (Super. Ct., Chelan County, Wash., 1956).

43. *See infra* note 45.

44. RESTATEMENT (SECOND) OF TORTS §§ 9, 430 (1965); *see also* R.J. Davis, *Weather Modification Litigation and Statutes*, in WEATHER AND CLIMATE MODIFICATION 770 (W.W. Hess ed. 1974); 4 WATER AND WATER RIGHTS, *supra* note 40, at 477.

45. Southwest Weather Resources, Inc. v. Rounsaville, 320 S.W.2d 211 (Tex. Civ. App., 1958), and Southwest Weather Resources, Inc. v. Duncan, 319 S.W.2d 940 (Tex. Civ. App., 1958), *both aff'd. sub nom.* Southwest Weather Resources, Inc. v. Jones, 160 Tex. 104, 327 S.W.2d 417 (1959). Ranchers, claiming that cloud seeding had decreased natural precipitation over their ranches, sought to enjoin farmers from cloud seeding to suppress hail. The court held that the seeding had, in fact, caused diminution of precipitation in those areas. Lay testimony played a crucial role in the outcome of this decision. 4 WATERS AND WATER RIGHTS, *supra* note 40, at 478, 480. *But cf.* Adams v. California, No. 10112 (Super. Ct., Sutter County, Cal., Apr. 6, 1964) (court found that the Yuba City flood would have been equally severe had no cloud-seeding activities taken place); Reinbold v. Sumner Farmers, Inc., No. 2734-C (Cir. Ct. Tuscola County, Mich. 1974) (plaintiff failed to prove that silver iodide released from ground-based generators could have travelled from release point to plaintiff's farm in time to have an effect on storm that caused damage); Samples v. Irving P. Krick, Inc., Nos. 6212, 6223 and 6224 (W.D. Okla., Dec. 22, 1954) (plaintiffs failed to prove that severe damage from storms and floods was caused by defendant's cloud-seeding activities); Pennsylvania Natural Weather Ass'n. v. Blue Ridge Weather Modification Ass'n., 44 Pa. D. & C.2d 749 (C.P. Fulton County, Pa., Feb. 28, 1968) (plaintiff failed to prove a link between their harm and the defendant's weather modification activities); Auvil Orchard Co. v. Weather Modification, Inc., No. 19268 (Super. Ct., Chelan County, Wash., 1956) (plaintiffs failed to prove that hail suppression projects caused damaging flash floods).

46. WEATHER AND CLIMATE MODIFICATION, *supra* note 44, at 770. The inability to bear the burden of proof imposed by the law accounts for the paucity of lawsuits involving weather modification. 4 WATERS AND WATER RIGHTS, *supra* note 40, at 479.

specifically,[47] this is not surprising. In *Adams v. California*,[48] for example, plaintiffs failed to convince the court that the flooding of Yuba City, California, would not have occurred "but for" the cloud seeding conducted on behalf of Pacific Gas and Electric Company. The court determined instead that the flood was caused by a freakish combination of storms and improper flood management by the state of California.[49]

To meet the burden of proving causation, plaintiffs must rely on expert witnesses, scientific data, or statistical probability analyses. Each of these methods, however, poses its own problems. Experts in weather modification are reluctant to testify to the possible injurious effects of their science for fear of retarding growth in the field and generating professional animosity.[50] Additionally, even when experts agree to testify on behalf of the plaintiff, their varying experiences and opinions lead to widely conflicting testimony.[51]

In the absence of expert testimony, the plaintiff must gather scientific data showing natural patterns of precipitation, streamflow, and snowpack.[52] Where this information is available, it is often incomplete or inaccurate.[53] Furthermore, its use is proving causation is limited due to the variability of individual clouds and storm systems.[54] Scientific data is useful in establishing long-range patterns for an area, but it does not establish how much precipitation a particular storm would have produced had it not been modified.[55]

Statistical probability analyses, whereby experiments are conducted to show the probability of certain weather phenomena occurring under certain meteorological conditions, are also available to a plaintiff.[56] Their usefulness, however, is limited in two ways. First, data collected from such experiments are admissible in court only upon a showing that those experiments were "conducted under circumstances similar to those in issue."[57] This alone is difficult to prove. Second, although capable of showing probability, statistical probability analyses are not capable of showing causation.[58] An analysis can go no further than show that it is highly prob-

47. W. Dicker, *Operational Weather Modification Prospects*, in WEATHER MODIFICATION TECHNOLOGY AND LAW 24 (R.J. Davis adn L.O. Grant ed. 1978).

48. No. 10112 (Super. Ct., Sutter County, Cal., April 6, 1964).

49. 4 WATERS AND WATER RIGHTS, *supra* note 40, at 478.

50. C. Lucero, *The Law for Weather Modification* in WEATHER MODIFICATION TECHNOLOGY AND LAW 65 (R.J. Davis and L.O. Grant, ed. 1978). Weather modifiers may take the stand in their own defense, claiming that there is no way the plaintiff can prove the adverse effects of their activities, while at the same time advertising to farmers that their science can indeed enhance precipitation significantly. W.A. Thomas, *supra* note 16, at 120.

51. H. TAUBENFELD, WEATHER MODIFICATION LAW, CONTROLS, OPERATIONS 45 (1965).

52. 4 WATERS AND WATER RIGHTS, *supra* note 40, at 479.

53. *Id.* This situation led one major commentator to suggest that the lack of records "is one of the reasons why widespread snowpack augmentation efforts should not be instituted in the mountains of the West until adequate snow surveys, runoff measurements, and climatological records are acquired." *Id.* at 480, n.70.

54. *Id.* at 479, 480.

55. *Id.*

56. 4 WATER AND WATER RIGHTS, *supra* note 40, at 480.

57. *Id.*; Beresford v. Pacific Gas and Electric Co., 45 Cal.2d 738, 748, 290 P.2d 498, 504 (1955), and Hammons v. Schrunk, 209 Ore. 127, 129, 305 P.2d 405, 410 (1956).

58. 4 WATER AND WATER RIGHTS, *supra* note 40, at 480-81.

able that the seeding of a particular storm system on a particular day resulted in the accumulation of an additional foot of snow. It cannot show that the seeding did, in fact, produce an extra foot of snow.[59]

The burden of proving causation poses an obstacle so insurmountable as to leave the weather modification plaintiff virtually without remedy.[60] Changing technology, however, provides some reason for optimism. Increasing sophistication in instrumentation will yield far more reliable and useful data.[61] Through discovery,[62] these data will be available to the plaintiff to prove causation.[63] For example, the primary purpose of CREST is to demonstrate statistically the actual effects of cloud seeding on winter storms and subsequent snowpack and runoff.[64] This requires that project designers develop methods of measuring exactly what impact any given seeding activity has on any given cloud or storm system at any given time.[65] This information will provide insight into how much precipitation the cloud or storm system would have yielded in the absence of seeding. Weather modifiers, therefore, may be put in the position of being their own worst enemy. While proving the effectiveness of their cloud-seeding techniques, they must also provide any information the claimant requests to prove causation.

B. *Trespass*

An actor who intentionally enters the land of another, thereby interfering with the landowner's interest in the exclusive possession of his land, is liable for trespass.[66] Although trespass need not involve damage to property, where damage results from the trespass, the actor is liable for that damage, even though he could not have reasonably anticipated that harm would result.[67] The actor himself need not enter the land. Trespass occurs when one invades another's property by "throwing, propelling or placing a thing either on or beneath the surface of the land or in the airspace above it."[68] Neither is it necessary to project foreign matter directly onto the other's land.[69] The actor need only have knowledge to a substantial certainty that his act will result in the entry of the foreign matter onto the other's property.[70] Thus, courts found a trespass when a defendant

59. To say there is a 70 percent probability that a particular seeding operation will produce two inches of additional snow also suggests a 30 percent probability that it will not. R. Hansen, *The Scientific Uncertainties: A Lawyer Responds*, in LEGAL AND SCIENTIFIC UNCERTAINTIES OF WEATHER MODIFICATION 23 (W.A. Thomas ed. 1977).

60. J.W. Kirby, *supra* note 24, at 60.

61. 4 WATERS AND WATER RIGHTS, *supra* note 40, at 481.

62. FED. R. CIV. P. 34 (any party may serve on another party a request to produce, inspect and copy data compilations).

63. R.J. Davis, *State Regulation of Weather Modification*, 12 ARIZ. L. REV. 35, 48 (1970).

64. *See supra* notes 3-6 and accompanying text.

65. R.J. Davis, *supra* note 63, at 48.

66. RESTATEMENT (SECOND) OF TORTS, § 158 (1965).

67. *Id.* at § 162.

68. *Id.* at § 158 comment i.

69. *Id.*

70. *Id.*; *see also* Roberts v. Permanente Corp., 188 Cal. App.2d 526, 530, 10 Cal. Rptr. 519, 523 (1961) (plaintiffs brought action for damages allegedly caused by dust eminating from defendant's cement plant and quarry).

cast water on the land of another,[71] or caused dirt to accumulate on another's land.[72]

An intrusion by artificially-induced snow arguably constitutes a trespass in the same manner as does an intrusion by water or dirt.[73] To recover under trespass, a landowner affected by CREST would have to prove that the government seeded the clouds with the intent of causing them to produce more snow than they would have produced naturally, and that the government knew with substantial certainty that the artificially-induced snow would fall on the plaintiff's land.[74] The scientific uncertainties inherent in weather modification make this a formidable task. Given the vicissitudes of clouds, storms, and wind systems, it is extremely difficult to prove that a defendant's act caused more precipitation to fall than would have fallen naturally, or that a defendant knew with substantial certainty where the increased precipitation would fall.[75] It is equally difficult, when the plaintiff's land is flooded, to prove that the flooding would not have occurred but for the defendant's cloud seeding or that the defendant knew with substantial certainty that his act would result in flooding the plaintiff's land. This is especially true where the plaintiff's land is located far from the seeding site.

CREST weather modifiers might commit a trespass by intentionally placing silver iodide particles or dry ice in the airspace above the plaintiff's land. Although courts in the past have required that the invading substance be perceivable by the naked eye,[76] courts have held more recently that invasion of the land by gases or microscopic particles such as air pollutants constitutes a trespass.[77] In these cases, however, substantial damage may be required as a prerequisite to liability.[78] Neither silver iodide nor dry ice, in and of themselves, have proven to cause substantial damage to land.[79]

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71. Dryden v. Peru Bottom Drainage Dist. No. 1, 99 Neb. 837, 158 N.W. 54 (1916) (where drainage ditch overflowed onto plaintiff's land, causing damage to crops, court held that "casting water upon the lands of another is trespass"). *See also* Union Pac. R. R. Co. v. Vale, Oregon Irr. Dist., 253 F.Supp. 251 (D. Or. 1966).

72. Senn v. Bunick, 40 Or. App. 33, 594 P.2d 837 (1979) (trespass occurred where defendant's earth moving activities resulted in moving dirt from defendant's land to plaintiff's adjoining land); Clark v. Wiles, 54 Mich. 323, 20 N.W. 63 (1884) (causing dirt to fall onto another's land is a trespass).

73. 4 WATERS AND WATER RIGHTS, *supra* note 40, at 486.

74. RESTATEMENT (SECOND) OF TORTS § 158 comment i (1965). The requirement that the defendant know with substantial certainty where the snow will land may leave those who suffer damage from the extra-area effects of weather modification without a remedy in trespass since the likelihood of extra-area effects are still largely unknown to scientists.

75. See *supra* notes 28-35 and accompanying text.

76. L. Putt and A. Bolla, *Invasion of Radioactive Particulates as a Common Law Trespass—An Overview*, 3 URB. L. REV. 206, 207 (1980).

77. Borland v. Sanders Lead Co., Inc. 369 So.2d 523 (Ala. 1979) (air pollution emitted from adjacent property constituted a trespass); Martin v. Reynolds Metals Co., 221 Or. 86, 342 P.2d 790 (1959), *cert. denied*, 362 U.S. 918 (1960) (toxic accumulations of fluoride emitted by defendant's aluminum reduction plant constituted a trespass); *see generally* L. Putt and A. Bolla, *supra* note 76.

78. *Borland*, 369 So.2d at 529. *Martin*, 342 P.2d at 794.

79. CREST ENVIRONMENTAL ASSESSMENT, *supra* note 1, at 25. Plaintiffs can also claim a trespass if airplanes are used to seed the clouds above their land. For airplane overflight to constitute a trespass, the plane must both "enter into the immediate reaches of the airspace next to the land," and substantially interfere with the owner's use and enjoyment of the land. RESTATEMENT

C. *Private Nuisance*

Whereas the law of trespass applies to physical invasions of land, private nuisance law applies to interferences with the use and enjoyment of land.[80] Implicit in the ownership of land is not only the right to its use for residential, commercial, agricultural, or other purposes, but also a right to derive from it a reasonable amount of comfort, convenience, and enjoyment.[81] Where floods, vibrations, or dust damaged property, and where loud noises or barking dogs interfered with the occupants' peace and comfort, courts have found a private nuisance.[82] "So long as the interference is substantial and unreasonable, and such as would be offensive or inconvenient to the normal person, virtually any disturbance of the enjoyment of the property may amount to a nuisance."[83] Unlike trespass, nuisance focuses on the damage inflicted rather than the conduct which caused the damage.[84]

1. *Nuisance Arising from Intentional Interference with Land*

Where the nuisance results from an intentional interference[85] with the use and enjoyment of land, liability is imposed only where the interference is both substantial and unreasonable.[86] Courts generally recognize physical damage to land, buildings, or vegetation, albeit minor, as substantial.[87] Courts are less inclined to find an interference substantial when it merely results in personal discomfort or annoyance.[88] In such cases, recurrence or continuance of the interference become a factor.[89]

In addition to being substantial, the interference must be unreasonable.[90] Whether an interference is sufficiently unreasonably to constitute a nuisance is determined by weighing the gravity of the harm to the plaintiff against the social utility of the defendant's conduct.[91] Although private nuisance is considered by some to be especially applicable to weather modification litigation,[92] this balancing of interests test could prove a barrier to recovery. The problem is illustrated in *Slutsky v. City of New*

(SECOND) OF TORTS § 159(2) (1965). It is probable, however, that airplanes used for cloud seeding would be flying too high and too infrequently for a trespass to be found. 4 WATERS AND WATER RIGHTS, *supra* note 40, at 481-482.

80. PROSSER AND KEETON ON TORTS 619 (5th ed. 1984).

81. *Id.*

82. *Id.*

83. *Id.* at 620.

84. RESTATEMENT (SECOND) OF TORTS § 822 comment b (1965).

85. The interference is intentional if the defendant "created or continued the condition causing the interference with full knowledge that the harm to the plaintiff's interests are occurring or are substantially certain to follow." PROSSER AND KEETON ON TORTS, *supra* note 80, at 625. Note that, again, the plaintiff must bear the difficult task of proving causation. See *supra* notes 44-63 and accompanying text.

86. PROSSER AND KEETON ON TORTS, *supra* note 80, at 626.

87. *Id.* at 627. RESTATEMENT (SECOND) OF TORTS § 827 comment d (1965).

88. PROSSER AND KEETON ON TORTS, *supra* note 80, at 627. RESTATEMENT (SECOND) OF TORTS § 827 comment d (1965).

89. RESTATEMENT (SECOND) OF TORTS § 827 comment c (1965).

90. PROSSER AND KEETON ON TORTS, *supra* note 80 at 626.

91. RESTATEMENT (SECOND) OF TORTS §§ 826-28 (1965).

92. WEATHER AND CLIMATE MODIFICATION, *supra* note 44, at 773; 4 WATERS AND WATER RIGHTS, *supra* note 40, at 490.

York.[93] There the plaintiff sought to enjoin the city from conducting experimental cloud seeding in the Catskill Mountains for fear that it would adversely affect his resort business. At the time, the city was experiencing a serious water shortage, which it hoped the seeding would remedy. Holding for the city, the court found that the "problem of maintaining and supplying the inhabitants of the City of New York . . . with an adequate supply of pure and wholesome water" far outweighed possible inconvenience to the plaintiff.[94]

CREST has the potential of providing millions of people with needed water and electricity.[95] Where courts employ a balancing test, a benefit of this magnitude would seem to outweigh any inconvenience or discomfort suffered by the individual landowner. If, however, CREST results in physical damage to property or buildings, the gravity of the harm to the plaintiff rises significantly as compared to the social utility of the project, strengthening the landowner's case.

2. *Nuisance Arising from Abnormally Dangerous Activity*

Nuisance may also arise from abnormally dangerous activity, in which case strict liability is imposed.[96] The controlling factor is the relationship between the activity and its surroundings. For example, detonating explosives in an uninhabited wilderness is not necessarily abnormally dangerous.[97] Detonating explosives in the middle of a large city, however, is abnormally dangerous and liability can be imposed despite an absence of negligence or intent to harm.[98]

A strict liability theory applicable to weather modification litigation would remove the difficult task of proving fault. For this reason, plaintiffs in at least three cases attempted to characterize weather modification as abnormally dangerous.[99] An activity is abnormally dangerous only if it involves a high degree of risk capable of causing great harm which cannot be eliminated by the exercise of reasonable care.[100] Additionally, the activity must be inappropriate to the place where it is conducted and its risks must outweigh its value.[101] To date, courts have refused to assign these attributes to weather modification.[102]

Little is known about the risks associated with large-scale projects such as CREST. Certainly if snowpack is already well above normal and the risk of avalanche high, an attempt to artificially induce more snowfall might be characterized as abnormally dangerous. That risk can be mini-

93. 197 Misc. 730, 97 N.Y.S.2d 238 (1950).
94. *Id.* at 240.
95. *See supra* notes 9-12 and accompanying text.
96. RESTATEMENT (SECOND) OF TORTS § 822 comment j (1965).
97. *Id.*
98. *Id.*
99. Reinbold v. Sumner Farmers, Inc., No. 2734-C (Cir. Ct., Tuscola Co., Mich. 1974); Adams v. California, No. 10112 (Super. Ct., Sutter Co., Cal., April 6, 1964).
100. RESTATEMENT (SECOND) OF TORTS § 520 (1965).
101. *Id.*
102. In Adams v. California, the court held that artificial nucleation of clouds was not in and of itself an ultra-hazardous activity. No. 10112 (Super. Ct., Sutter Co., Cal., April 6, 1964).

mized, however, by constantly monitoring snowpack and accurately forecasting seasonal storms so that seeding can be discontinued when the risk of avalanche appears. Care can also be taken to minimize the impact on populated areas. Only with further experimentation will the degree of risk associated with large-scale weather modification projects be fully understood and its true character revealed.

IV. DEFENSES TO TORTS

A. *Federal Tort Claims Act*

Plaintiffs face another obstacle where the defendant in the weather modification suit is the federal government, as would be the case in litigation arising from CREST. The doctrine of sovereign immunity, recognized by the United States Supreme Court since 1821,[103] prohibits suits against the federal government without its consent.[104] In 1946, the United States government adopted the Federal Tort Claims Act (FTCA), waiving its immunity from certain kinds of suits.[105] The waiver does not apply, however, to any claim "based upon the exercise or failure to exercise or perform a discretionary function or duty on the part of a federal agency or an employee of the government, whether or not the discretion involved abuse."[106]

Congress neglected to define "discretionary function," but in *Dalehite v. United States*[107] the United States Supreme Court clarified the exception by employing a "planning-operational" dichotomy. "Planning" decisions were considered discretionary by the Court, and included decisions to initiate programs and establish plans, specifications, or operating schedules to carry out those programs.[108] Adopting a broad construction of "discretionary," the Court held that "[w]here there is room for policy judgment and decision there is discretion."[109] In 1955, the Court implied a narrower construction of "discretionary," suggesting that once the government decided to undertake a project, its discretionary function ended.[110] Courts

103. Cohens v. Virginia, 19 U.S. (6 Wheat.) 264 (1821).

104. PROSSER AND KEETON ON TORTS, *supra* note 80, at 1033.

105. The FTCA allows the government to be sued:

> for money damages . . . for injury or loss of property, or personal injury or death caused by the negligent or wrongful act or omission of any employee of the Government while acting within the scope of his office or employment, under circumstances where the United States, if a private person, would be liable to the claimant in accordance with the law of the place where the act or omission occurred.

28 U.S.C.A. § 1346(b); *see* Indian Towing Co. v. United States, 350 U.S. 61, 68-69 (1955).

106. 28 U.S.C. § 2680(a) (1948). Grounded upon the doctrine of separation of power, the purpose of the exception was "to keep the courts from interfering with lawful legislative and executive decisions." Coates v. United States, 181 F.2d 816, 817-18 (8th Cir. 1950).

107. 346 U.S. 15 (1953), *reh'g denied*, 346 U.S. 841 (1953). The case grew out of a disaster in Texas City in 1947 when fertilizer, packaged and stored in ships, exploded. The Court held that the government's plan for manufacturing, handling, exporting, and shipping the fertilizer was within the discretionary exemption.

108. *Id.* at 35-36.

109. *Id.*

110. Indian Towing Co. v. United States, 350 U.S. 61 (1955). In response to the plaintiff's claim that the government had negligently operated a lighthouse, the Court declared that, once the government decided to operate the lighthouse, it "was obligated to use due care to make

today are fairly consistent in holding that governmental immunity extends only to decisions made on the planning level and not to "operational" decisions, i.e. those made during the execution of planning-level decisions.[111] They are far less consistent, however, in where they draw that line.[112]

Whether an individual suffering damage as a result of CREST can maintain an action in tort against the federal government depends on whether the damage-producing decision is discretionary or operational. Any decision by Congress or the Department of the Interior to conduct the program will be discretionary.[113] Rules or regulations promulgated for the implementation of CREST will also be discretionary.[114] Far less clear, however, is the classification of decisions made while implementing the rules and regulations, or decisions based on potentially inaccurate scientific data.[115] Where a technology is relatively new and the risks associated with it are largely unknown, the critical decision is that which authorized the project despite uncertainty. For CREST, that decision will be made at the Congressional level, rendering it discretionary and unactionable under the Federal Tort Claims Act.[116]

The FTCA presents an additional problem. Because weather modification can adversely affect a large number of people over a wide area, claims would be most expeditiously handled by class action suits. Such suits are effectively barred, however, by the FTCA's administrative exhaustion requirement.[117] Before suing the government, a claimant must apply to the appropriate federal agency for an administrative settlement of the claim.[118] The claimant must then present a statement showing the dollar amount of damages alleged.[119] An exact dollar figure is usually impossible to supply, however, where some class members are unnamed or even unknown. In *Lunsford v. United States*,[120] a class action against the federal government, plaintiffs claimed that a flood resulting in 283 deaths

certain that the light was kept in good working order. . . ." *Id.* at 69. *See* C. Doyle, *Government Liability for Nuclear Testing Under the FTCA*, 15 U.C.D. 1003, 1012 (1982).

111. PROSSER AND KEETON ON TORTS, *supra* note 80, at 1040.

112. *See* Harris and Schnepper, *Federal Tort Claims Act: Discretionary Function Exception Revisited*, 31 U. MIAMI L. REV. 161 (1976); *Federal Tort Claims: A Critique of the Planning Level—Operational Level Test*, 11 U.S.F.L. REV. 170, 173-74 (1976).

113. C. Doyle, *Government Liability for Nuclear Testing Under the FTCA*, 15 U.C.D. 1003, 1016 (1982).

114. *See id.*

115. *See id.* at 1019. The following cases illustrate this ambiguity: Nevin v. United States, 696 F.2d 1229 (9th Cir. 1983) (chemist's decision to use a particular strain of bacterium in simulated biological warfare attack on San Francisco in 1950 was discretionary), *cert. denied*, 104 S. Ct. 70 (1983); Graves v. United States Coast Guard, 692 F.2d 71 (9th Cir. 1982) (operation of a dam on the Colorado River was discretionary); Griffin v. United States, 500 F.2d 1059 (3rd Cir. 1974) (government agency's scientific measurements were conducted by a professional, not a policymaker, and were, therefore, operational); Bartholomae Corp. v. United States, 135 F.Supp. 651 (S.D. Cal. 1955) (test manager's decision regarding timing of a blast during a nuclear testing program was discretionary), *aff'd*, 253 F.2d 716 (9th Cir. 1957); Boyce v. United States, 93 F.Supp. 866 (S.D. Iowa 1950) (blasting to deepen the Mississippi River, which caused damage to property, was discretionary).

116. *See supra* note 113 and accompanying text.

117. 28 U.S.C. § 2675(a) (1949).

118. *Id.*

119. *Id.*

120. 570 F.2d 221 (8th Cir. 1977).

and widespread property damage was the result of experimental cloud seeding conducted under a Bureau of Reclamation contract. Upholding the district court's dismissal of the suit, the court of appeals held that the claimants failed to meet the administrative exhaustion requirement by failing to identify all the claimants by name and to state a specific amount of damages. Because the FTCA makes no provision for filing administrative claims against the government "on behalf of a class of similarly situated individuals," the court concluded that "the FTCA clearly presupposes the existence of an identifiable claimant or claimants with whom the government can negotiate a settlement."[121]

B. *Flood Control Act of 1928*

When flooding causes damage, government weather modification projects such as CREST have a legal defense in the Flood Control Act of 1928.[122] The Act provides that "[n]o liability of any kind shall attach to or rest upon the United States for any damage from or by floods or flood waters at any place. . . ."[123] There is evidence that Congress intended that the Act apply only to floods caused by federal flood control projects,[124] but courts have often interpreted the statutory language literally. In *National Manufacturing Co. v. United States*,[125] the leading case on the issue, the court held that the Act immunized the federal government from liability "wherever floods or flood waters have been substantial and material factors in destroying or damaging property."[126] More recently, the Ninth and Fifth Circuit Courts held that the immunity applies only where damage resulted from flood control projects.[127]

In *Lunsford*,[128] the government raised the Flood Control Act as a defense, claiming it was immune from liability for flood-caused damage. Moving to strike the defense, the plaintiff contended that the Act served to immunize the government only where flooding resulted from a federal flood control project. Noting that the plaintiff's case was not without merit, the district court nevertheless denied the motion, stating that it felt bound by *National Manufacturing*.[129] The court of appeals affirmed.[130]

Weather modifiers concede that flooding is a serious risk of cloud seeding.[131] If the Flood Control Act applies to all cases of government-

121. *Id.* at 225.
122. 33 U.S.C. § 702c (1928).
123. *Id.*
124. *See* Lunsford v. United States, 570 F.2d 221, 227-30 (8th Cir. 1977); Graci v. United States, 301 F.Supp. 947, 950-54 (E.D. La. 1969), *aff'd*, 456 F.2d 20 (5th Cir. 1971), *cert. denied*, 412 U.S. 928 (1973).
125. 210 F.2d 263 (8th Cir. 1954), *cert. denied*, 347 U.S. 967 (1954).
126. *Id.* at 271.
127. Graci v. United States, 301 F.Supp. 947 (E.D. La. 1969), *aff'd*, 456 F.2d 20 (5th Cir. 1971), *cert. denied*, 412 U.S. 928 (1973); Peterson v. United States, 367 F.2d 271 (9th Cir. 1966).
128. 418 F.Supp. 1045 (D.S.D. 1976), *aff'd*, 570 F.2d 221 (8th Cir. 1977).
129. *Id.* at 1054.
130. *Lunsford*, 570 F.2d at 229. Calling the plaintiffs' motion to strike premature, the court refused to rule on the scope of governmental immunity under the Flood Control Act until evidentiary hearings had been held to determine exactly what caused the flooding at issue. *Id.* at 230.
131. SIERRA ECOLOGY PROJECT, VOLUME V, *supra* note 36, at 8.

caused flooding, it effectively bars actions based on flooding caused by governmental cloud seeding. The rulings in the Fifth and Ninth Circuits,[132] however, and the sympathy toward the plaintiffs' position expressed in *Lunsford* may well indicate a move away from the strict view of *National Manufacturing.*

V. INVERSE CONDEMNATION

To date, neither commentators nor courts have analyzed the applicability of the law of eminent domain to weather modification.[133] Where the weather modifier is the federal government, however, the law of eminent domain can provide a remedy to injured landowners. Before proceeding, it should be noted that the plaintiff's burden of proving causation is as troublesome as under tort law.[134]

Eminent domain is the right or power of the government to take private property for public use or benefit without the owner's consent.[135] This right is conditioned upon the payment of just compensation to the landowner whose property is taken.[136] Generally, when the government wishes to acquire private property for public use it institutes formal condemnation proceedings and pays just compensation. When it fails to compensate, the plaintiff may sue the government by instituting an action in inverse condemnation.[137]

Four tests have been used to determine whether a compensable "taking" has occurred.[138] Under the "physical invasion" test, the use or occupation of private property by the government or one of its agents constitutes a taking which requires compensation under the fifth amendment.[139] Under the "noxious use" test, compensation is almost never required when a private landowner is prohibited by the government from using his land in a way which is harmful to his neighbors.[140] "The idea is that compensation is required where the public helps itself to good at private expense, but not when the public simply requires one of its members to stop making a nuisance of himself."[141] The "diminution of value" test

132. *See supra* note 127 and accompanying text.

133. Telephone interview with R.J. Davis, Professor of Law, Brigham Young University College of Law (August 31, 1984).

134. *See supra* notes 44-60 and accompanying text.

135. 1 J. SACKMAN, NICHOLS ON EMINENT DOMAIN § I.11 (Rev. 3rd ed. 1982); United States v. 2,005.32 Acres of Land, 160 F.Supp. 193 (D.S.D. 1958); United States v. 209.25 Acres of Land, 108 F.Supp. 454 (D. Ark. 1952), *rev'd sub nom.* U.S. v. Willis (8th Cir. 1954), *cert. denied,* 347 U.S. 1015; City of Scottsdale v. Municipal Court of City of Tempe, 90 Ariz. 393, 368 P.2d 637, (1962).

136. "[N]or shall private property be taken without just compensation." U.S. CONST. AMEND. V.

137. Under the Tucker Act, a landowner who feels that his property has been "taken" by governmental activity may seek to enforce the requirement of just compensation by instituting an action in inverse condemnation. 28 U.S.C. §§ 1346(a), 1491 (1976).

138. Michelman, *Property, Utility, and Fairness: Comments on the Ethical Foundations of "Just Compensation" Law,* 80 HARV. L. REV. 1165, 1183-1201 (1967). *See generally,* Ticer, *"Takings" Under the Police Power—The Development of Inverse Condemnation as a Method of Challenging Zoning Ordinances,* 30 SW. L.J. 723, 728 (1976).

139. Michelman, *supra* note 138, at 1184-90.

140. *Id.* at 1196-1201.

141. *Id.* at 1196.

looks to the magnitude of harm in determining whether compensation is required.[142] This test is applied most often to regulations of "innocent" property use and devaluation resulting from public development.[143] Finally, under the "balancing of interests" test, the need for compensation is determined by weighing the social gain against individual loss.[144]

Of greatest utility to the weather modification claimant is the physical invasion test.[145] Whether a government-caused invasion of snow constitutes sufficient use or occupation of land to constitute a taking is untested. A compensable taking has been found, however, where property was invaded by "superinduced additions of water, earth, sand or other material."[146] In *Coates v. United States*,[147] actions taken by the government to improve the navigability of the Missouri River caused the river to change its course and, as a result, dump thousands of tons of sand on the plaintiff's property. The court found a compensable taking even though the government had not directly placed the sand on the plaintiff's property. "We can conceive of a no more direct invasion of a man's property than the alleged deposit upon it of several hundred thousand tons of sand as a direct consequence of work being done to the adjacent stream. The pilings may not have been driven upon the plaintiffs' land but the pilings and other mechanical work done caused the sand to be thrown there."[148]

Any permanent physical occupation of private property by government is considered a taking *per se*, regardless of how minimal the actual damage, or how great the public benefit.[149] But the invasion need not be permanent. A taking is found when the physical invasion is "continuous"[150] or sufficiently "recurrent."[151] Unfortunately, there is no formula for determining when a physical invasion of property is sufficiently recurring to constitute a taking. One court found that low altitude flights every two minutes over private property was sufficiently recurring.[152]

Frequency is only one measurement of the relative intrusiveness of a government activity. In *Portsmouth Harbor Land and Hotel Co. v. United States*,[153] the Supreme Court held that where the government's intent was to subordinate the plaintiff's land so that the government could use it

142. *Id.* at 1190-96.
143. *Id.* at 1191.
144. *Id.* at 1193-96.
145. "A 'taking' may more readily be found when the interference with property can be characterized as a physical invasion by government . . . than when the interferences arise from some public program adjusting the benefits and burdens of economic life to promote the common good." Penn Central Transp. Co. v. New York City, 438 U.S. 107, 124 (1978), *reh'g denied*, 439 U.S. 883 (1978).
146. Pumpelly v. Green Bay & Mississippi Canal Co., 80 U.S. (13 Wall.) 166, 181 (1870); Coates v. United States, 93 F. Supp. 637, 638-39 (Ct. Cl. 1950).
147. 93 F.Supp. 637 (Ct. Cl. 1950).
148. *Id.* at 638.
149. Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419, 434-35 (1982); United States v. Cress, 243 U.S. 316 (1917). *See also* 2 J. SACKMAN, NICHOLS ON EMINENT DOMAIN, § 6.2 (Rev. 3rd ed. 1982).
150. United States v. Dickinson, 331 U.S. 745, 749 (1947).
151. North v. United States, 94 F.Supp. 824, 825 (C.D. Utah 1950); United States v. Causby, 328 U.S. 256 (1946).
152. Jensen v. United States, 305 F.2d 444, 445 (Ct. Cl. 1962).
153. 260 U.S. 327 (1922).

"whenever it saw fit," the government had taken a servitude over that land.[154] The Court further stated that every successive trespass by the government could be taken as an indication of an "abiding purpose" to take an easement over that land.[155]

During the CREST demonstration programs, clouds will be seeded for approximately five years, during winter only, and on a sporatic basis.[156] The effects of each seeding operation might be felt for days or even weeks. Where springtime runoff causes flooding, mudslides, or erosion, detrimental effects could extend to months or years. Whether the invasion of augmented snows caused by such cloud seeding will be sufficiently recurring to constitute a compensable taking is uncertain. There can be little doubt, however, that each successive seeding operation is additional evidence of the government's intent to use the land below "whenever it [sees] fit," for the collection and storage of snow.

Finally, fairness plays a vital role in determining whether a taking requires compensation.[157] In *Armstrong v. United States*,[158] the Supreme Court declared that the fifth amendment guarantee of just compensation was "designed to bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole."[159] The Court has not yet established a workable formula for determining exactly when "justice and fairness" require compensation.[160] Behind most analyses of the fairness question is the proposition that private landowners should not have to bear a disproportionate share of a public burden.[161] Put more succinctly, "there is no ethical justification for enriching A at B's expense, no matter if A does (we think) gain more than B loses."[162]

If large-scale weather modification projects such as CREST bear fruit, many people will benefit. Where the benefits are so great, and the burden so disproportionate, fairness and justice dictate that those who are solely burdened and unbenefitted receive just compensation.[163]

VI. Recommendations and Conclusion

Cast adrift on uncharted waters, a landowner forced to rely on traditional legal remedies faces inordinate difficulties. For this reason, legislation authorizing projects such as CREST must include a means of compensating injured landowners or, at a minimum, a means of bringing traditional remedies within their reach. To date, CREST contains no such

154. *Id.* at 329.
155. *Id.* at 329-30.
156. CREST Program Plan, *supra* note 3, at 4.
157. Berger, *A Policy Analysis of the Taking Problem*, 49 N.Y.L. Rev. 165, 166-67 (1974); *see generally* Michelman, *supra* note 138.
158. 364 U.S. 40 (1960).
159. *Id.* at 49.
160. Penn Central Transp. Co. v. New York City, 438 U.S. 107, 124 (1978).
161. Michelman, *supra* note 138; *Penn Central*, 438 U.S. 123-24.
162. Michelman, *supra* note 138, at 1176.
163. *Penn Central*, 438 U.S. at 123-24.

provision.[164]

One alternative is to alleviate the plaintiff's seemingly impossible burden of proving causation by shifting the burden of proof to the government.[165] Certainly the government is in a far better position to prove the effects of its highly technical and experimental activities than is the individual landowner. Alternatively, a 1977 government study suggests that the government provide expert witnesses to those claiming injury.[166] Any witnesses provided by the government, however, should be selected from truly independent sources such as universities or professional associations. In addition, federal weather modification activities should be specifically included within the Federal Tort Claims Act.[167] Further, to accommodate class action suits, claimants should be exempted from the FTCA's administrative exhaustion requirement of providing exact damage figures.[168]

Any legislative provision compensating the injured or providing them with witnesses or other assistance will require a source of revenue. Revenue to pay compensation can be raised by selling the water generated by cloud seeding.[169] Under existing laws of prior appropriation,[170] "developed" water[171] belongs to those whose efforts produced it.[172] Once the government proves the existence and quantity of augmented water, it can be classified as "developed" and can be sold by the government.[173] Additionally, those who receive the benefits of weather modification could be taxed to offset the cost of compensating those who are injured by it.

As of this writing CREST is awaiting final review and clearance by the Office of Management and Budget, after which it will be sent to Congress for deliberation. At that time, legislators should carefully consider any means to bring compensation within reach of injured landowners. Where traditional remedies are inadequate, creative solutions must be found.

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164. See *supra* note 41 and accompanying text.

165. WEATHER MODIFICATION ADVISORY BOARD, U.S. DEP'T OF COMMERCE, 1 MANAGEMENT OF WEATHER RESOURCES 154 (1978) (hereinafter cited as 1 MANAGEMENT OF WEATHER RESOURCES).

166. AN OVERVIEW, *supra* note 40, at 166.

167. 1 MANAGEMENT OF WEATHER RESOURCES, *supra* note 165, at 149.

168. *Id.* at 150. In suggesting this exemption, the Weather Modification Board stated that, because property owners are inherently affected as a group and the facts governing liability are common to all, a claimant should be allowed to apply to the Administrative Agency on behalf of the class. *Id.*

169. AN OVERVIEW, *supra* note 40, at 164.

170. In most western states, the doctrine of prior appropriation governs the right to use water. Under the doctrine, the date on which one first diverts and applies water to beneficial use establishes one's superiority of right to that water. *See* F. TRELEASE, WATER LAW 12 (3rd ed. 1979).

171. "Developed" waters are new waters, not previously part of a river system. Southeastern Colorado Water Conservancy Dist. v. Shelton Farms, Inc., 187 Colo. 181, 187, 529 P.2d 1321, 1325 (Colo. 1975).

172. *See id.*

173. AN OVERVIEW, *supra* note 40, at 164.