LESSONS LEARNED: RISK MANAGEMENT STRATEGIES AS PROJECTS GROW, MATURE, AND CLOSE

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Presented to:

Rocky Mountain Mineral Law Foundation, Special Institute on

Regulation and Development of Coalbed Methane

November 14-15, 2002, Denver, CO.

Coalbed methane (CBM), no longer an emergent resource, is now maturing as a significant source of this nation's burgeoning demand for natural gas. The current operating environment for CBM development has evolved in spite of unprecedented environmental controversy. Such controversy has been atypical of that experienced in developing conventional gas resources. Environmental tort litigation has pursued CBM development in every producing basin, has forced all major operators to address claims with crisis management practices, and has substantially altered and complicated the regulatory requirements for environmental compliance.

Much of the controversy surrounding CBM development practices could have been either minimized or avoided by tailoring established risk, environmental, and quality assurance management practices to this new business opportunity. The vast amount of useful information collected in response to litigation and new regulations during the past two decades is now sufficient to provide the CBM industry with a blueprint for managing risk. In a nutshell, we have learned that the costs needed to plan and implement a reasonable environmental risk assessment and management system is a fraction of the cost needed to defend against litigation. We have also learned that although the majority of litigious environmental claims against the industry were unsubstantiated, operators repeatedly found themselves defenseless and unprepared to confront claims in the absence of environmental baseline data. Operating companies caught up in the current frenzy to acquire and develop CBM resources need to realize that both their stakeholders and the general public need to be better informed about real development risks. Such risks can only be quantified if formally addressed. Risk assessment and environmental management practices are a cost of doing business that should be included in economic forecasts.

In order to assist in the defense, or prevention, of these types of litigation, the following will discuss the common law legal theories that are typical in these types of litigation and the key issues to be aware of with respect to each. Further, we will discuss the importance and the methodology for gathering baseline information to assist in the defense of this type of litigation. Finally, we will take a look at some possible scenarios to protect producers in the future from this type of liability.

1. Common Law Theories of Liability[1]

Each litigation will take on its own personality and will evolve on its own path. This will influence the claims and defenses that come to the forefront. That notwithstanding, there are several common law claims for relief that are typically pled in an environmental litigation involving coalbed methane production and the alleged peripheral impacts. The following is intended to provide a basic source for the fundamental elements of each theory as well as thoughts and strategies for the defense of each claim.

a. Strict Liability

Strict liability is applied in situations in which the activity at issue is so inherently fraught with risk that should the activity result in damage to another person or property, the individual or entity engaged in the activity is liable for such damage without any further showing of fault or malfeasance. The courts in Colorado, New Mexico and Wyoming are all guided by the Restatement (Second) of Torts in the application of the theory of strict liability.[2] Under the Restatement, the following factors are to be considered prior to applying the theory of strict liability.

a. Existence of a high degree of risk of some harm to the person, land or chattels of others;

b. Likelihood that the harm that results from it will be great;

c. Inability to eliminate the risk by the exercise of reasonable care;

d. Extent to which the activity is not a matter of common usage;

e. Inappropriateness of the activity to the place where it is carried on; and

f. Extent to which its value to the community is outweighed by its dangerous attributes.[3]

Strict Liability has been recognized in Colorado for only two activities: blasting dynamite and impounding water.[4] However, the Colorado legislature exempted even

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[1] This section focuses on the law in Colorado, Wyoming and New Mexico.

[2] Hartford Fire Ins. Co. v. Public Serv. Co. of Cob., 676 P.2d 25 (Cob. App. 1983); First Nat’l Bank v. Nor-Am Agr. Prods. Inc., 88 N.M. 74, 537 P.2d 682 (1975); Wheatland Irrigation Dist. v.McGuire, 537 P.2d 1128 (Wyo. 1975).

[3] Restatement (Second) of Torts § 520.

[4] Garden of the Gods Village v. Hellman, 133 Colo. 286, 294 P.2d 597 (1956); Garnet Ditch & Reservoir Co. v. Sampson, 48 Colo. 285, 110 P. 79 (1910).

the impounding of water from the strict liability standard.[5] It is particularly important in Colorado to distinguish between "ultrahazardous" or "abnormally dangerous" activities and "inherently dangerous" activities. "Ultrahazardous" and "abnormally dangerous" activities are those giving rise to strict liability. An activity that is classified as "inherently dangerous" still requires a showing of negligence but is subject to a higher standard of care than ordinary negligence.[6] In New Mexico, strict liability has been imposed only for blasting.[7] There is no New Mexico precedent for the proposition that drilling for oil and gas constitutes an abnormally dangerous activity. To the contrary, New Mexico courts have uniformly and consistently refused to extend the doctrine even to cases where explosions have occurred. See Otero v. Burgess, 84 N.M. 575, 505 P.2d 1251, 1255 (1973) (holding that the storing of dynamite, despite its explosion, did not give rise to strict liability); Guiterrez v. Rio Rancho Estates, Inc., 93 N.M. 755, 605 P.2d 1154 (1980)(refusing to expand the doctrine of strict liability beyond the use of explosives). Moreover, the New Mexico Supreme Court has held that drilling an oil well is not an ultrahazardous activity for purposes of determining a principle's liability for the conduct of an independent contractor. Southern California Petro. Corp. v. Royal Indem. Co., 70 N.M. 24, 369 P.2d 407, 410 (1962).

In deciding whether the doctrine of abnormally dangerous activity under Section 520 applies to natural gas production, the court in Williams v. Amoco Production Co., 734 P.2d 1113 (Kan. 1987), held that "the drilling and operation of natural gas wells is not an abnormally dangerous activity in relation to the type of harm sustained by appellees." Id. at 1123; see also Romero v. Mobil Exploration, 727 F. Supp. 293 (W.D.La. 1989) ("snubbing", a form of natural gas drilling, is not ultrahazardous). According to the court in Williams, "natural gas is not a 'harmful agent' once it is raised to the surface of the earth. Nor does natural gas ruin drinking water, destroy vegetation, or injure livestock. Moreover, natural gas is not a substance which is known to be 'mischievous' if it gets on the property of others." Williams, 734 P.2d at 1123.

Wyoming courts distinguish between "absolute liability," by which a defendant is liable for harm without regard to fault, and "strict liability," which imports a liability brought about through negligence.[8] Absolute liability will not be imposed on a landowner where the injury results from acts of God, war, or the malicious torts of a third person. Absolute liability will be imposed if the landowner is making a non-natural and hazardous use of his land viewed in light of the surroundings and locality. If his use is natural, he will be judged by negligence standards.

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[5] C.R.S. § 37-87-104 (1990 Repl. Vol.).

[6] Imperial Distr. Serv.. Inc. v. Forrest, 741 P.2d 1251 (Colo. 1987).

[7] Gutierrez v. Rio Rancho Estates. Inc., 93 N.M. 755, *605* P.2d 1154 (1980); Ruiz v. Southern Pac Trans. Co., 97 N.M. 194, 638 P.2d 406 (App. 1981).

[8] Wheatland Irrigation Dist. v. McGuire, 537 P.2d 1128 (Wyo. 1975); Jacoby v. Town of City of Gillette, 62 Wyo. 487, 174 P.2d 505 (1946).

Obviously, the first defense of this claim is a legal defense. You must attack this claim in pre-trial dispositive motions and attempt to have it removed from the case on summary judgment. The arguments are straight forward under the restatement elements.

In addition, this claim can be defended by contesting the element of causation inherent to the claim. It is not enough for the plaintiff to establish that the defendant is engaged in conduct that is considered to be subject to a strict liability or absolute liability standard. They must also establish that the conduct was the proximate cause of their harm.

Causation is one of the keys to the defense of a claim involving coalbed methane production under any theory of liability. Causation is a common theme in these types of cases because if held to their proof on this issue, many plaintiff's do not have the scientific evidence to support their claims. Summary judgment is mandated "against a party who fails to make a showing sufficient to establish the existence of an element essential to that party's case, and on which that party will bear the burden of proof at trial." Celotex, 477 U.S. at 322. "Nor will a mere argument or contention that a triable issue exists suffice or a general allegation without an attempt to show the existence of those factual elements comprising the claim or defense." Schmidt v. St. Joseph's Hosp., 105 N.M. 681, 736 P.2d 135 (1987) (citing J. Walden, *Civil Procedure in New Mexico* 258-259 (1973)). See Renaud v. Martin Marietta Corp., 972 F.2d 304, 306 (10th Cir. 1992) (summary judgment proper unless there is a basis in plaintiff's evidence to support the conclusion that the defendant has caused plaintiff's injuries).

The Ninth Circuit Court of Appeals considered the scientific evidence of causation in Daubert v. Merrell Dow Pharmaceuticals, Inc., 43 F.3d 1311 (9th Cir.), cert denied 116 S.Ct. 189 (1995). In this opinion the Court considered the adequacy of the evidence regarding causation presented by the plaintiffs to support their allegation that the ingestion of Benedictin during pregnancy caused birth defects. Id. The Ninth Circuit noted that "what plaintiffs must prove is not that Benedictin causes some birth defects, but that it caused *their* birth defects." Id. at 1322 (emphasis in original). The testimony offered in that case that it was **possible** that the Benedictin caused their birth defects was ruled inadequate to present to the jury and the entry of summary judgment in the defendant's favor was affirmed. Id.

In Thomas v. FAG Bearings Corp., 846 F.Supp. 1382 (W.D.Mo. 1994), the Court considered the adequacy of the proposed evidence regarding the source and cause of the groundwater contamination at issue in that case. The defendant, FAG Bearings, had filed third-party complaints against a variety of corporate defendants alleging that releases of TCE and TCE related substances from the third-party defendants had contributed to the contamination of the Silver Creek and Saginaw Village CERCLA sites. Id. at 1386. The Court noted in this case that "A defendant may have committed a wrong on his own property, and a plaintiff may have been injured on his own property, but unless the defendant's wrong is causally-related to plaintiffs' injury, the defendants should not be held liable." Id. at 1390. The hydrogeologist retained by FAG Bearings could not state that any contaminant had migrated from any third-party defendants' site to the drinking water wells at issue. Id. at 1391. In deposition testimony the hydrogeologist in the FAG Bearings case could not identify the source of the contamination at the sites at issue in this case and could only state that the third-party defendants were potential contributors to the contamination. Id. at 1391-92. The court ruled that scientific opinions "that cannot establish a probability cannot be the basis on which a reasonable juror can find in favor of a proposition." Id. at 1394. The Court summarized the opinions of the hydrogeologist as follows, "Overton's opinions are concocted of impermissible bootstrapping of speculation upon conjecture." Id. In conclusion, "While the highly questionable evidence of release is nearly fatal to FAG Bearings' case, the absence of admissible evidence on the issue of causation leaves no doubt. These deficiencies are likewise fatal to all state law claims raised by FAG Bearings." Id. at 1398. Summary judgment was entered in favor of all third-party defendants as a result of FAG Bearings' failure and inability to present any credible evidence of causation.

In Todd by Todd v. Merrell Dow Pharmaceuticals, Inc., 942 F.2d 1173 (7th Cir. 1991), the plaintiff attributed a newborn's respiratory problems to a drug the mother received to arrest labor. The plaintiffs in Todd failed to offer any expert testimony in support of causation. In finding summary judgment for the defendants, the court held "to establish a causal relationship between a particular product and alleged injured, a plaintiff generally present credible expert witness testimony." Id. at 1179.

b. Trespass

Trespass is an entry upon or under the surface of real estate of another without the permission or invitation of the person lawfully entitled to possession of the real estate. C.J.I.-Civ. 18:1; Magliocco v. Olson, 762 P.2d 681 (Colo. App. 1987); Burt v. Beautiful Savior Lutheran Church of Broomfield, 809 P.2d 1064, 1067 (Colo. App. 1990). There is some debate as to what constitutes an entry on property. Diminution in value of property is not a compensable injury under trespass; it is only a measure of damages if a sufficient injury has been established. Good Fund. Ltd. - 1972 v. Church, 540 F. Supp. 519 (D. Cob. 1982) rev'd on other grounds, McKay v. U.S. 703 F.2d 464 (10th Cir. 1983) (diminution in property value caused by conjectural, transitory, and ephemeral public reaction over contamination was not compensable as a trespass); see also Mock v. Potlatch Corp., 786 F. Supp. 1545 (D. Ida. 1992) (summary judgment appropriate because diminution in property value does not meet requirement for trespass injury). It can be argued that an invasion must cause damage to be actionable. Cobai v. Young, 679 P.2d 121 (Cob. App. 1984)(refers to trespass as a force that in usual course of events will damage property of another); see also Maddy v. Vulcan Materials Co., 737 F. Supp. 1528 (D. Kan. 1990)(plaintiff must prove substantial damage to land); Bradley v. American Smelting & Refining Co., 635 F. Supp. 1154 (W.D. Wash. 1986)(rejecting claims of trespass for arsenic and cadmium emissions because the plaintiffs' properties were not physically injured); Borland v. Sanders Lead Co., 369 So.2d 523 (Ala. 1979)(invasion must affect nature and character of land and cause substantial damage).

It can be argued that the entry must be onto "the property of another" and, therefore, an action for trespass will not lie in favor of a subsequent landowner of the same parcel of property or in favor of a landlord against a tenant lawfully in possession. Burt v. Beautiful Savior

Lutheran Church, 809 P.2d 1064 (Cob. App. 1990). Cases from other jurisdictions directly support this argument. Wellesley Hills Realty Trust v. Mobil Oil Corp., 747 F. Supp. 93 (D. Mass. 1990): owner of property asserted trespass claim against former owner claiming petroleum hydrocarbon contamination occurred when former owner occupied the property. The court dismissed the trespass claim. "A trespass, however, requires an unprivileged, intentional intrusion on land in the possession of another.... In this case, Mobil owned and was in possession of the property when it allegedly released the oil causing the contamination. Thus, Mobil's releases of oil were not unprivileged, and Mobil was clearly not intruding on land in the possession of another. Mobil's releases of oil on its own land, therefore, cannot constitute a trespass." Id. at 99 (emphasis in original).

It can also be argued that the plaintiff must have been in actual or constructive possession of the property when the trespass occurred. See Hugunin v. McCunniff, 2 Colo. 367 (1874)("trespass quare clausum fregit lay only by one having possession, in fact, of the premises trespassed upon, at the time of the trespasses."); Sullivan v. Clements, 1 Colo. 261 (1871)(entry on land prior to possession held not a trespass); see also Butler v. Pollard, 800 F.2d 223 (10th Cir. 1986)("plaintiffs could only recover for trespass to their property that occurred after they became owners of the property."); Jaycox v. E.M. Harris Bldg. Co., 754 S.W.2d 931 (Mo. App. 1988)("Jaycox had the burden of proving that he was rightfully in possession as against the builder at the time of the trespass."). When the trespass itself is caused by an object or instrumentality entering the property of another Colorado requires an intent to do the act that itself constitutes, or inevitably causes, the intrusion. Miller v. Carnation Co., 33 Colo. App. 62, 516 P.2d 661 (1973). A landowner who sets a force in motion which, in the usual course of events, will damage the property of another, is guilty of trespass on such property. Burt v. Beautiful Savior Lutheran Church, 809 P.2d 1064 (Colo. App. 1990) (citing Cobai v. Young, 679 P.2d 121 (Colo. App. 1984)(snow sliding from a roof into plaintiffs house)); Docheff v. City of Broomfield, 623 P.2d 69 (Colo. App. 1980)(discharge of drainage water onto property of adjoining landowner); Miller v. Carnation Co., 39 Colo. App. 1, 564 P.2d 127 (1977)(failure to remove chicken manure resulting in pests intruding on plaintiffs property).

Under New Mexico law, trespass is an unauthorized entry on the land of another which constitutes an indirect infringement of another's right of possession. Padilla v. Lawrence, 101 N.M. *556*, 685 P.2d 964 (App. 1984); North v. Public Serv. Co. of N.M., 94 N.M. 246, 608 P.2d 1128 (App. 1980). Where there is no physical invasion of and damage to property, as with intangible intrusions such as noise, blowing particles, and odor, the cause of action is for nuisance rather than trespass. Padilla v. Lawrence, 101 N.M. *556*, 685 P.2d 964 (App. 1984). Blowing particles can constitute a trespass only if they settled upon and damaged the plaintiffs property. Padilla v.Lawrence, 101 N.M. *556*, 685 P.2d 964 (App. 1984). Trespass requires possession of the injured party. The gist of trespass is an injury to the right of possession. Thus, to maintain a trespass action, the plaintiff must have been in actual or constructive possession of the land at the time of the alleged trespass. Pacheco v. Martinez, 97 N.M. 37, 636 P.2d 308 (App. 1981). A plaintiff who purchased land after the trespass was committed cannot maintain an action for such prior trespasses, but may recover for trespasses which continue after the purchase. Garver v. Public Serv. Co. of N.M., 77 N.M. 262, 421 P.2d 788 (1966). Every trespass entitles the owner to a verdict for some damages. North v. Public Serv. Co. of N.M., 94 N.M. 246, 608 P.2d 1128 (App. 1980). Thus, a finding of intentional trespass raises a presumption of at least nominal damages. Thompson v. Fahey, 94 N.M. 35, 607 P.2d 122 (1980).

In Wyoming, the gist of an action for trespass is interference with possessory rights, and the plaintiff must have a possessory interest to maintain an action for trespass. Ruby Drilling Co. v. Billingsly, 660 P.2d 377 (Wyo. 1983). Consent of possessor or another authorized to give consent is an absolute defense to trespass. Salisbury Livestock Co. v. Colorado Cent. Credit Union, 793 P.2d 470 (Wyo. 1990). Punitive damages may be awarded upon a showing of reckless disregard for or willful indifference to the plaintiffs rights; actual malice or wicked intent is not necessary. Sears v. Summit. Inc., 616 P.2d 765 (Wyo. 1980).

In the context of coalbed methane production, the theory is often that the removal of vast amounts of water results in a depressurization of the entire coal seam and the methane is released through naturally occurring fractures and charges the aquifer or the surface. One possible defense is the alleged invasion is not from the "property of another." If the plaintiff is the landowner on whose property the production facility is located, they may not be able to pursue a claim for trespass. Moreover, the defense can pursue the theory that the gas is naturally occurring under the property. That is, after all, why they call if natural gas.

Once again, the factor of causation is key to the defense of this claim. Plaintiffs will detect hydrogen sulfide in their well water or gas seeps on their property and claim that the coalbed methane production is responsible. Often, the only evidence they offer is circumstantial. That is, there is evidence of natural gas on the plaintiff's property and the defendant is involved in coalbed methane production in the area. It is not uncommon to be able to establish through isotopic analysis that the gas on the plaintiff's property or in their water well is distinct from the gas being produced from the coal seam. In other words, it is coming from somewhere else. We have seen instances in which their water well was down gradient from a pig pen and the water problems were associated with fecal matter entering the well from that source. In spite of that fact, coalbed methane was blamed for the water problems. In another instance, a water well was actually completed in a shallow coal seam. Once they had used enough water, it began to produce natural gas. Their water well was, in essence, a coalbed methane gas well.

c. Nuisance

Under Colorado law, nuisance is a non-trespassory invasion of another's use and enjoyment of land. Allison v. Smith, 695 P.2d 791 (Colo. App. 1984). Plaintiffs must be able to establish that the defendant unreasonably and substantially interfered with their use and enjoyment of the property. Lowder v. Tina Marie Homes. Inc., 43 Colo. App. 225, 601 P.2d 657 (1979); Miller v. Carnation Co., 33 Colo. App. 62, 516 P.2d 661 (1973). Substantial interference is interference that is offensive, inconvenient or annoying. Northwest Water Corp. v. Pennetta, 479 P.2d 398 (Colo. App. 1970).

As with trespass, the argument can be made that the alleged nuisance must interfere with another's interest in property and cannot relate to a single piece of property and be asserted against a former occupant. See. e.g., Labbe v. Steffens, 752 P.2d 1067, 1068 (Colo. App. 1988) (adjacent car wash held to be a nuisance because of "adverse effects to adjacent property"); Allison v. Smith, 695 P.2d 791, 794 (Colo. App. 1984) (operation of well-drilling service constituted a nuisance to adjoining landowners); Lowder v. Tina Marie Homes. Inc., 43 Colo. App. 225, 601 P.2d 657, 658 (1979) (soil blown from vacant lot onto plaintiffs property); Miller v. Carnation Co., 33 Colo. App. 62, 516 P.2d 661, 662 (1973) (flies from egg ranch damaged plaintiffs property and made it unusable). Cases from other jurisdictions support this argument. Philadelphia Elec. Co. v. Hercules. Inc., 762 F.2d 303, 313-15 (3rd Cir.), cert. denied 474 U.S. 980 (1985)(a property owner brought a nuisance claim against a former owner of the same property for groundwater contamination on the property. The court held that the current property owner had no cause of action for nuisance because private nuisance is intended to resolve "conflicts between neighboring, contemporaneous land uses."). Allied Corp. v. Frola, 730 F. Supp. 626, 634 (D.N.J. 1990) (granting motion to dismiss because "nuisance, by definition, involves acts by a defendant occurring off the land owned by a plaintiff'); Amland Props. Corp. v. Aluminum Co. of Am., 711 F. Supp. 784, 807-08 (D.N.J. 1989) (refusing to allow the owner of an industrial plant to bring a nuisance claim against the former owner for PCB contamination). Wilson Auto Enterprises. Inc. v. Mobil Oil Corp., 778 F. Supp. 101 (D.R.I. 1991)("Wilson has not alleged that Mobil invaded his interests while Mobil was a neighboring, contemporaneous landowner proximate to Wilson's property. To create liability as a private nuisance, the offending condition must come from outside the plaintiffs land. A buyer of property cannot assert a private nuisance claim against a seller -- or the seller's lessee -- for contamination that occurred before the sale.); Wellesley Hills Realty Trust v. Mobil Oil Corp., 747 F. Supp. 93 (D. Mass. 1990)("[T]he law of private nuisance requires that the interference be to persons outside the land upon which the condition is maintained.

In New Mexico, nuisance is a non-trespassory invasion of another's interest in the private use and enjoyment of land or an unreasonable disturbance of rights in adjoining land. Jellison v. Gleason, 77 N.M. 445, 423 P.2d 876 (1967); Abbinett v. Fox, 103 N.M. 80, 703 P.2d 177 (App. 1985); Padilla v. Lawrence, 101 N.M. *556, 685* P.2d 964 (App. 1984). Accordingly, a personal injury claim cannot proceed under a theory of nuisance. First Nat'l Bank in Albuquerque v. Nor-Am Agr. Prods.. Inc., 88 N.M. 74, 537 P.2d 682 (1975). Liability for intentional conduct requires that the conduct be unreasonable. An invasion is unreasonable if the gravity of the harm outweighs the utility of the actor's conduct or if the harm is serious and the financial burden of compensating for the harm would not make continuing the conduct unreasonable. Padilla v. Lawrence, 101 N.M. *556,* 685 P.2d 964 (App. 1984).

Nuisances are classified as either nuisances per se or nuisances in fact. Scott v. Jordan, 99 N.M. 567, 661 P.2d 59 (App. 1983). A nuisance per se is an act, occupation, or structure which is a nuisance at all times and under any circumstance, regardless of location or surroundings. Koeber v. ApexAlbuq Phoenix Exp., 72 N.M. 4, 380 P.2d 14 (1963). The storage of explosives has been held not be a nuisance per se. Otero v. Burgess, 84 N.M. *575, 505* P.2d 1251 (App. 1973). Operation of truck terminal also was held not to be a nuisance per se, but was a nuisance in fact. Koeber v. Apex-Albuq Phoenix Exp., 72 N.M. 4, 380 P.2d 14 (1963). A nuisance in fact is an act, occupation, or structure which may become a nuisance by reason of circumstances, location, or surroundings. Koeber v. Apex-Albuq Phoenix Exp., 72 N.M. 4, 380 P.2d 14 (1963).

Compliance with state and federal regulations may constitute a partial defense to nuisance. Padilla v. Lawrence, 101 N.M. *556,* 685 P.2d 964 (App. 1984); Otero v. Burgess, 84 N.M. *575, 505* P.2d 1251 (App. 1973).

The plaintiff may be able to obtain an injunction if the activity complained of is continuous in nature and if its frequency renders the damages remedy inadequate. Where a nuisance gives every promise of continuing, damages will seldom, if ever, be adequate. Scott v. Jordan, 99 N.M. 567, 661 P.2d 59 (App. 1983). A continuing nuisance is one which occurs so often that it can fairly be said to be continuing, although it is not constant or unceasing. Padilla v. Lawrence, 101 N.M. *556,* 685 P.2d 964 (App. 1984). In determining whether to grant an injunction, the court may consider the investment made by the business in capital structures and employees and nature of the area. Padilla v. Lawrence, 101 N.M. *556*, 685 P.2d 964 (App. 1984); Scott v. Jordan, 99 N.M. *567,* 661 P.2d 59 (App. 1983). Priority of occupation also is relevant. Padilla v. Lawrence, 101 N.M. *556,* 685 P.2d 964 (App. 1984). This obvisouly presents a huge risk in the context of natural gas production. An injunction against coalbed methane production would have far reaching economic impacts.

A plaintiff may recover damages for interference with comfort and enjoyment as well as diminution in property value. It is not necessary to prove loss of value to recover for annoyance and discomfort. Aguayo v. Village of Chama, 79 N.M. 729, 449 P.2d 331 (1969); Padilla v. Lawrence, 101 N.M. *556,* 685 P.2d 964 (App. 1984). The plaintiff bears the burden of proving damages. Padilla v. Lawrence, 101 N.M. *556*, 685 P.2d 964 (App. 1984). If the plaintiff fails to meet a measure of proof sufficient for the trier of fact to fix the amount of damages, the trial court is justified in refusing to award damages. Padilla v. Lawrence, 101 N.M. *556,* 685 P.2d 964 (App. 1984). Thus, a realtor's testimony that property would be difficult to market due to its proximity to the nuisance was insufficient to support an award of damages, in light of her contrary testimony that property had commercial value and was being rented. Padilla v. Lawrence, 101 N.M. *556,* 685 P.2d 964 (App. 1984).

In Wyoming, nuisance is defined as a class of wrong which arises from an unreasonable, substantial, unwarranted, or unlawful use by a person of his own property, which works an obstruction or injury to the right of another. Bowers Welding & Hotshot. Inc. v. Bromley, 699 P.2d 299 (Wyo. 1985); Hem v. Lee, 549 P.2d 286 (Wyo. 1976); Sheridan Drive-In Theatre. Inc. v. State, 384 P.2d 597 (Wyo. 1963). Liability for nuisance may be imposed on the basis of an intentional or negligent invasion of the plaintiffs interests or conduct which is abnormal and out of place in its surroundings, falling within the principle of strict liability. Timmons v. Reed, 569 P.2d 112 (1977). Whether particular conduct is a nuisance is judged by a reasonable, ordinary person's use of the land and not by the standard of a person who requires exceptional freedom from deleterious uses. Hem v. Lee, 549 P.2d 286 (Wyo. 1976); Sheridan Drive-In Theatre. Inc. v. State, 384 P.2d 597 (Wyo. 1963).

d. Negligence

Negligence is defined as a failure to do an act which a reasonably careful person would do, or the doing of an act which a reasonably careful person would not do, under the same or similar circumstances to protect oneself or others from injury. Imperial Dist. Serv.. Inc. v. Forrest, 741 P.2d 1251 (Cob. 1987); Matt Skorey Packard Co. v. Canino, 142 Cob. 411, 350 P.2d 1069 (1960); CJ.I.Civ. 3d 9:4. A cause of action founded on negligence requires proof of the following elements:

a. a duty or obligation, recognized by law, requiring the defendant to conform to a certain standard of conduct for the protection of others against unreasonable risks;

b. a failure or breach of duty by the defendant to conform to the standard required by law;

c. a sufficient causal connection between the offensive conduct and the resulting injury; and

d. actual loss or damage resulting to the interest of the plaintiff. Bayly. Martin & Fay. Inc. v. Pete's Satire. Inc., 739 P.2d 239 (Cob. 1987); C.J.I.-Civ. 3d 9:1.

Under Colorado law, there is a different standard of negligence applied to inherently dangerous activities. One carrying on an inherently dangerous activity must exercise the highest possible degree of skill, care, caution, diligence and foresight with regard to that activity, according to the best technical, mechanical and scientific knowledge and methods which are practical and available at the time of the claimed conduct which caused the claimed injury. The failure to do so is negligence. Imperial Dist. Serv. v. Forrest, 741 P.2d 1251 (Cob. 1987); C.J.I.-Civ. 3d 9:5. A trial court may only instruct a jury on the highest degree of care standard when all minds concur that a business, by its inherent nature, is fraught with peril to the public. Imperial Dist. Serv. v. Forrest, 741 P.2d 1251 (Cob. 1987). The court determines as a matter of law the existence and scope of the duty to which a defendant is to be held. Imperial Dist. Serv. v. Forrest, 741 P.2d 1251 (Cob. 1987).

Conduct may be found to be inherently dangerous when;

(1) the material being dealt with has inherently dangerous properties;

(2) the defendant possesses expertise in handling the inherently dangerous material or in performing the inherently dangerous activity; and

(3) the general public is not capable of recognizing and guarding against the dangerous potential of certain situations. Federal Ins. Co. v. Public Serv. Co., 194 Colo. 107, 570 P.2d 239 (1977).

The following have been found to be inherently dangerous:

(1) The distribution of electricity; Federal Ins. Co. v. Public Serv. Co., 194 Colo. 107, 570 P.2d 239 (1977);

(2) The distribution of propane; Blueflame Gas. Inc. v. Van Hoose, 679 P.2d 579 (Colo. 1984); and

(3) The operation of an amusement park; Hook v. Lakeside Park Co., 142 Colo. 277, 351 P.2d 261 (1960).

The following have been found not to be inherently dangerous;

(1) The storage and delivery of caustic chemicals to a dumpsite; Imperial Dist. Serv. v. Forrest, 741 P.2d 1251 (Cob. 1987);

(2) Concrete; Mile Hi Concrete. Inc. v. Matz, 842 P.2d 198 (Cob. 1992);

(3) The operation of a ski area; Pizza v. Wolf Creek Ski Devel. Corp., 711 P.2d 671 (Cob. 1985); and

(4) The installation of heat-tape; Melton By and Through Melton v. Larrabee, 832 P.2d 1069 (Cob. App. 1992).

In New Mexico, a cause of action founded on negligence requires proof of the following elements:

a. a duty or legal obligation recognized by law requiring defendant to conform to a certain standard of conduct for the protection of others against unreasonable risks; and

b. a failure or breach of this duty is recognized when the conduct which unreasonably amplifies risk of harm to a person to whom the duty is owed is present. Baxter v. Noce, 107 N.M. 48, 752 P.2d 240 (1988).

In Wyoming, a cause of action founded on negligence requires proof of the following elements:

a. a duty or obligation, recognized by law requiring the defendant to conform to a certain standard of conduct for the protection of others against unreasonable risks;

b. a failure or breach of duty by the defendant to conform to the standard required by law;

c. a sufficient causal connection between the offensive conduct and the resulting injury; and

d. actual loss or damage resulting to the interest of the plaintiff. Keehn v. Town of Torrington, 834 P.2d 112 (Wyo. 1992).

Res ipsa loquitur is often used in these types of cases in an attempt to shortcut the finding of negligence. Res ipsa loquitur is a rule of evidence, and as such gives rise to a rebuttable presumption of the defendant's negligence but does not create a substantive claim for relief. Stone's Farm Supply. Inc. v. Deacon, 805 P.2d 1109 (Cob. 1991). Res ipsa loquitur allows an inference of breach of duty and causation, and requires the defendant to prove by a preponderance of the evidence that he was not negligent. Stone's Farm Supply. Inc. v. Deacon, 805 P.2d 1109 (Cob. 1991). This evidentiary inference may only be applied to cases in which the evidence establishes that in the ordinary course of events an injury would not occur except through the negligence of the person in exclusive control and management of the injuring instrumentality. Trujeque v. Service Merchandise Co., 117 N.M. 388, 872 P.2d 361, 364 (1994). Exclusive control and management requires that the sole power or authority to superintend, direct or oversee the instrumentality is held by the defendants. Id. Res ipsa boquitur may be applied when the following elements are established:

a. the event is the kind that ordinarily does not occur in the absence of negligence;
b. other responsible causes, including the conduct of plaintiff and third persons, are sufficiently eliminated by the evidence; and
c. the indicated negligence is within the scope of the defendant's duty to the plaintiff. Stone's Farm Supply. Inc. v. Deacon, 805 P.2d 1109 (Cob. 1991); Freedman v. Kaiser Foundation Health Plan of Colorado, 849 P.2d 811 (Cob. App. 1992); Hartford Fire Ins. Co. v. Public Serv. Co. of Colo., 676 P.2d 25 (Cob. App. 1983); C.J.I.-Civ. 3d 9:17.

Colorado has specifically adopted Restatement (Second) of Torts §328D, as the statement of the law of res ipsa loquitur. Hartford Fire Ins. Co. v. Public Serv. Co. of Cob., 676 P.2d 25 (Colo. App.1983). Wyoming has specifically adopted the language from Cooley on Torts, § 1424 (3d ed. 1906). "[W]hen a thing which causes injury, without fault of the injured person, is shown to be under the exclusive control of the defendant, and the injury is such as, in the ordinary course of things, does not occur if the one having such control uses proper care, it affords reasonable evidence, and the absence of an explanation, that the injury arose from the defendant's want of care."

As a defense against the application of this evidentiary theory one can assert the following argument. The alleged injuring instrumentality is natural gas. It is absurd to suggest that the defendants (coalbed methane producers) exercise exclusive control and management over natural gas in a natural gas producing basin. That is why they call it natural gas! The defendants did not place the natural gas in the basin nor did they have anything to do with its creation in that location. Millions of years of geologic forces created the natural gas about which the plaintiffs complain. Coalbed methane production should not be a case in which res ipsa loquitur can properly be applied.

In addition, as with all of the other claims the causation theory will be key to this defense. Otherwise, it is a fairly standard negligence defense theory that works best. Establish through expert testimony that the well, from planning through completion and production, was managed properly and all precautions were taken. This will involve testimony regarding the drilling and completion of the well. In addition, establishing compliance with all laws and regulations supports the defense against negligence. Compliance with regulations is not a complete defense to a negligence claim. However, it is good evidence of compliance with the appropriate standards.

PRACTICAL STEPS TO AVOID LITIGATION OR ASSIST IN THE DEFENSE

Many of the claims made against operators of coalbed methane production facilities could have been foreseen and addressed in more cost-effective ways with a marginal amount of environmental baseline information. But in every case, the absence of baseline data led to considerable controversy and uncertainty regarding whom to blame for a variety of complaints. Fearing a loss of health and safety, local residents chose to blame operators and sought relief through litigation. In this context, prudent baseline measurement and monitoring practices are relatively easy and inexpensive to implement.

This section of the paper summarizes the typical environmental complaints commonly attributed to CBM operations in the San Juan, Black Warrior, and Powder River basins over the past two decades. It also provides selected examples of cost-effective methods which operators can use for planning and implementing baseline studies. Without such studies, the task of differentiating between environmental changes caused by production and those resulting from other causes becomes very difficult. Recommended methods focus on understanding production practices from a perspective of the potential impacts on the physical and geochemical properties of regional aquifers. Baseline measurements are best used for assessing risk and targeting areas where health, safety, and quality of life issues are of paramount. There are also substantial secondary benefits to these measurements. The right information can help operators to constrain reservoir engineering models, detect reservoir compartmentation and anisotropy, verify the need for infill drilling, assess wellbore integrity, and predict the potential for souring gas reserves.

Summary of complaints attributed to CBM operations

The most common complaints attributed to CBM practices in the San Juan, Black Warrior, and Powder River basins have included the following: a. the loss of domestic water quantity, b. progressive deterioration of either surface or groundwater quality, and c. the emergence of potentially dangerous concentrations of free and dissolved methane in both water and soils. The overwhelming majority of such complaints can, and have been documented to arise from a variety of natural causes. Nevertheless, the following examples summarize information, contained in legal documents or published by regulatory agencies, uniquely attributing these problems to CBM production practices.

Loss of domestic water quantity

Several reasons have been proposed to explain declining water yields in domestic water wells that may be completed in aquifers hundreds of feet above or below a producing coal horizon. A frequently quoted and widely held popular view is that drawing water from a coalbed aquifer is like drawing water from a glass through a straw. Lower the water level in the glass, and you will lower the water level in the straw. This simplistic view is reinforced by the misconception that local aquifers are of regional extent and that they are both vertically and laterally homogeneous. Another commonly used concept is that there are numerous types of permeable conduits that could connect coal seams with overlying and underlying aquifers. Examples cited are naturally-occurring fractures, fractures induced by either underground mining or hydraulic fracturing practices, and poorly-constructed producing or abandoned oil and gas wells.

The most pressing concerns expressed by both state and federal regulators regard CBM production in the proximity of basin margins. It has been asserted that downdip production can lower water levels in domestic water wells completed near or within outcropping CBM producing horizons. It has also been alleged that lowered water levels near the outcrop may increase the risk for spontaneous coal combustion.

Deteriorating surface and groundwater quality

Changes in water quality attributed to CBM practices are usually cited to arise from induced changes in the oxidation state of water in wells. Most claims assume that coalbed methane is free to migrate and bubble through a domestic water well, thereby displacing free oxygen or generating conditions favorable for a chemically reducing environment. Such a progressive loss of oxygen can promote the growth of sulfate-reducing bacteria (SRB's), and iron-reducing bacteria (IRB's). SRB's strip sulfate ions of their oxygen for respiration. The byproduct of this metabolic process is carbon dioxide and hydrogen sulfide gas. The presence of hydrogen sulfide gas is unmistakable. It emanates as an offensive odor usually described as similar to the smell of rotten eggs. When water containing dissolved hydrogen sulfide comes in contact with air, it reacts to form sulfuric acid that can corrode faucets, shower heads, and appliances. IRB's, on the other hand, will allow iron to readily dissolve in water. Dissolved iron and sulfide ions can combine to form suspended particles of iron sulfide that will impart a dark gray color to water. When reduced waters rich in dissolved iron exits a home's plumbing system and comes in abrupt contact with air, the iron quickly oxidizes and precipitates as an insoluble, rust-colored iron hydroxide. This precipitate can stain porcelain fixtures, faucets, and even discolor laundry.

Bacterial related chemical reactions are also commonly invoked as agents of chemical change in increasingly oxidized waters. Such reactions are offered in support of claims that assume aquifer water levels have fallen as a result of CBM production. A water pump operating in progressively shallow water will draw more oxygenated water that is in closer contact with air. If oxidation occurs in a well bore containing dissolved iron, then iron-oxidizing bacteria will convert the iron to an iron hydroxide precipitate. This imparts a rusty red color to water and, if present in large concentrations, will render water opaque. The water will also tend to have an unpleasant taste, commonly described as metallic.

Both chemical reduction and oxidation of domestic aquifers have also been cited to result from chemical reactions induced when produced waters, discharged at the surface, are allowed to infiltrate shallow aquifers. Surface discharge can also affect surface water chemistry by changing salinity or modifying historic concentrations of metal ions.

Emergence of free and dissolved methane

Methane seepage is the third and last type of complaint attributed to CBM production activities. Seeps engender the greatest fear among plaintiffs because methane poses a safety hazard. Methane is an odorless and colorless gas that can lead to spontaneous explosions if allowed to reach concentrations of between 5% and 15% by volume in air. This range is defined by the lower and upper explosive limit of methane, respectively. Such concentrations can be reached in two ways: via exsolution of dissolved methane that is allowed to collect in an enclosed and unventilated space, or by the accumulation of free gas seeping to the surface.

Methane seeps can also physically displace normal oxygen levels in soil and kill vegetation. Extensive gas seeps can noticeably alter the vegetative landscape. Another physical effect of active gas seeps is that methane can behave as a carrier gas that transports undesired concentrations of buried hydrogen sulfide gas to the surface. In sufficiently high concentrations, sulfide gas brought to the surface can irritate skin and eyes and, in the worst possible scenario, can lead to loss of consciousness or death.

Litigators too easily explain the origin of dissolved methane in water wells and methane seeps as follows: desorption of gas from coal, responding to lowered hydrostatic pressures, releases large quantities of gas into the subsurface environment which was not there prior to development. Implied in such a statement is the idea that gas released from a coalbed methane reservoir has easy access to the surface and surrounding aquifers.

Both litigators and regulatory agencies have commonly identified four migration mechanisms to account for methane in domestic aquifers and for methane seeps. The first is vertical migration through large, natural fractures that extend vertically from the producing reservoir to the surface or domestic aquifer. The second pertains to gas migration along access paths provided by well bore conduits. In the San Juan Basin, for example, well installation practices conducted prior to the 1950's left the production casing annulus of deep oil and gas wells uncemented across both the shallower Fruitland Formation and overlying strata. Consequently, when CBM operations began in 1980's, desorbed gas was free to migrate vertically from the Fruitland coal along the wellbore annulus and into shallow aquifer horizons[1]. Domestic water wells can also provide gas conduits to the surface. For example, gravel packing of wells completed within a producing Wyodak coal seam was at one time an appropriate completion method for domestic water wells in the Powder River Basin. However since CBM operations have begun there, water yield in several such wells has declined, and the gravel pack has provided a conduit for gas to migrate to the surface.

The final two gas seep mechanisms attributed to CBM production have been alleged to occur near basin margins where gas seeps emerge along the outcrop belt of producing coal seams. Methane liberated during production could migrate updip until it emanates from the outcrop or shallow subcrop. Alternatively, down-basin production could lower water levels near the outcrop and allow gas to be released at the surface via *in-situ* desorption of gas-saturated coal seams.

Setting objectives for a baseline sampling and monitoring program

Objectives for developing a strategic environmental management (EMS) program are best established by evaluating risk. Based on the typical complaints described above, consequential risk analysis methods offer the best alternatives for evaluating the objectives, costs, and benefits of an EMS program. Such methods are rigorous and systematic, and involve all stakeholders, beginning with uppermost management. In brief, successful risk analysis entails the following steps: a. itemizing a risk list; b. ranking the items on the list; c. identifying the potential consequences of each risk; d. ranking consequences; e. prioritizing the relative importance of both risks and consequences; f. determining when and where both risks and consequences are likely to be most prevalent; g. and making choices to decide which risks and consequences are acceptable, which ones are not acceptable, and how to go approach mitigation.

The majority of information needed to assess risk resides in readily available historic records, maps, permits, climatic data, wireline logs, synoptic imagery, and other publicly available data. Such reconnaissance-level information should be interpreted to provide the risk-assessment team with the following: a. a historical context for evaluating water quality and quantity delivered by various aquifers; b. a historical context for known gas seeps; c. a historical context for areas that may be affected by other potentially hazardous anthropogenic activities; d. a regional framework for determining "baseline" sampling areas; and e. a regional framework for designating "critical" areas at risk that should be sampled or monitored. These data are best summarized in risk-consequence maps of the development area, showing how acreage ranks in terms of environmental sensitivity. Such maps can then be used to prioritize development in least sensitive areas, while reserving sensitive areas for development until a baseline sampling and monitoring program can be established.

Designing a cost-effective baseline sampling and monitoring program

A cost-effective baseline sampling and monitoring program limits the scope of investigation by focusing first on three areas of greatest concern. First, are the "critical" areas where the risk of impacting local residents or the environment is greatest. Second, are the areas where water well problems unrelated to CBM production operations are already known to exist. And third, are the areas where either the risks of impacting production revenues or the opportunities for maximizing revenues are greatest.

Using sampling grids provides the most cost-effective means to cover large areas in a baseline study, and to compare and contrast data from different areas. The grid spacing used should be appropriate for capturing a minimum amount of information at a desired scale. Once a grid is defined, it is easy to collect one sample at random anywhere inside a grid square (an example of random stratified sampling). A sufficient number of samples should be collected in any targeted area to provide meaningful statistical measures such as mean and variance. Sampling grid locations should also be chosen to cover terrain both within and outside any area of particular of interest. Such an approach minimizes bias, and allows objective comparison of different areas through the use of accepted statistical hypothesis-testing methods. A sufficient number of samples should be also be collected to establish statistically meaningful "threshold" values of the environmental parameters that are most useful for warning operators of impending problems. Threshold values are formally defined and used to establish action triggers. Examples of actions to be taken might include additional sampling for more complete analysis, notifying residents and regulatory agencies of potential problems, or remediation.

There are three types of samples that define an initial environmental baseline sample collection hierarchy. These are: 1. field samples, 2. standard laboratory samples, and 3. special laboratory samples. Data gathered from such a hierarchy should be processed to identify the minimum number of measurement parameters that are useful for characterizing the environmental parameters of greatest concern. Ultimately, a baseline sampling program strives to find sampling techniques which can be most easily deployed in the field, requiring a minimum amount of laboratory analysis, and which can be used to regularly and easily monitor the groundwater environment.

Field sampling methods are screening tools, and offer the most cost-effective means available to establish the potability, oxidation state, and general chemical properties of water in aquifers over a large area. Only a few hand-held field instruments need to be calibrated daily for these analyses. These are used to measure acidity (pH), redox potential (Eh), temperature, conductivity (used to determine the relative concentration of dissolved chemicals), and dissolved oxygen (dO). Other useful data pertain to observations made with the senses such as water color, clarity, and smell. It is relatively easy and inexpensive to collect hundreds of field samples in a single season among a variety of sites that include springs, water wells, CBM production wells, streams, surface reservoirs, irrigation ditches, and other sources of aquifer recharge. This prolific source of information can then be used to selectively target a smaller suite of samples for more comprehensive and expensive laboratory analyses.

Sampling of the ambient air above various soil and outcrop horizons also provides a good means for screening monitoring sites where soil gas probes should be installed. Such sampling is usually performed along specified transects where gas seeps have been informally documented or are suspected to occur. Outcrops, producing well locations, and abandoned well locations, are common risk targets.

A variety of hand-held and truck-mounted “sniffer” detectors are available for analysis of ambient air quality. These can also be used to analyze headspace gases of soil samples, gases liberated from water samples collected in springs and streams, or gases liberated when domestic well water is used to fill sinks or buckets. Of the available organic vapor analyzers (OVA), flame ionization devices (FID) offer the greatest sensitivity to low hydrocarbon concentrations. “Walking the ground” should be considered an important component of field analysis methods. Public education forums can help persuade residents to cooperate with an operator’s efforts to randomly conduct sniffer surveys of residential basements and crawl spaces. Educating a concerned public prior to production activities should always be encouraged. Any excuse for two-way communication will provide valuable clues regarding water quality issues already facing a community.

It is often quite impractical to make static water level measurements in domestic water wells. Obtaining permission to access properties is a significant problem in western states. Even if access is granted, many operators are leery of disassembling well heads for fear that they may be accused of damaging the well in some way. Other operators may opt to drill and maintain monitor wells at relatively low costs. At the very least, operators should randomly inspect a specified number of domestic well heads. A surprisingly large number of wells are poorly constructed, lack sanitary seals, or have other obvious problems that can account for poor water quality and quantity. Numerous plaintiffs who have complained of declining water yields and water quality were unaware that their “do-it-yourself” maintenance practices allowed them to inoculate their wells with bacteria. As a result, rich bacterial cultures growing in their wells were so prolific that thick slime coated the aquifer, thereby restricting aquifer yield.

Once an area has been screened with data from field analyses, there are more detailed and expensive analyses which can be conducted on a relatively small number of targeted samples. Targeting strategies are most effective when based on statistical analysis of field data. Results of such analyses can be used to unambiguously differentiate among aquifers. Each aquifer can then be selectively sampled and analyzed for a variety of specified inorganic and organic constituents. Wet chemical analyses are standard and relatively inexpensive. A typical suite of analytes includes the major ions as follows: calcium, magnesium, potassium, and sodium (positively charged ions) and carbonate, bicarbonate, sulfate, and chloride (negatively charged ions). Checking the charge balance between positively and negatively charged major ions is one good way to check quality control. Other analytes that are typically measured are iron and manganese, dissolved nitrogen compounds, and non-reactive ions such as bromine and fluorine. Some operators also measure the concentration of selected metals listed by the Resource Conservation and Recovery Act as potentially hazardous. It is also customary to measure other properties of water in the laboratory, such as pH, and conductivity.

In the search for potential sources of hydrocarbon contamination, samples should be analyzed for the total concentration of dissolved organic carbon components. Benzene, toluene, ethyl benzene, and xylene (BTEX) analyses should be performed routinely as they are the best indicators of migrated petroleum or leaking sources of distillate and gasoline. Special samples are collected to determine the concentration of dissolved methane in water. Analysis of dissolved gas concentrations is particularly important because naturally-occurring bacterial methane is a common and often ubiquitous constituent of aquifers.

If gaseous hydrocarbons are found to be dissolved in water samples or discovered to be emerging along seeps, it is important to characterize them. Chromatography and stable isotopic analyses are the best means available to assess the likely source of gas contaminants. Such measurements require special laboratory analyses which are reliably performed by only a handful of laboratories in the U.S. and around the world. Stable isotopic analyses of carbon, hydrogen and oxygen are the most expensive environmental measurements generally made in CBM production-related baseline studies. In some areas, the stable carbon isotopic content of methane is sufficient to distinguish between methane of thermogenic and bacteriogenic origin. However, there are many instances when the stable isotopic composition of carbon and hydrogen in methane, carbon in associated carbon dioxide, and the hydrogen and oxygen of associated water samples are all needed to adequately differentiate among potential gas sources. The stable isotopic composition of gas samples collected near or at the surface should be compared with stable isotopic analyses of methane collected from a select number of producing wells tapping all producing horizons.

Quality Assurance

There are three important design components to every sampling program. These are 1. documenting and implementing standardized sampling and analysis protocols; 2. making provisions for quality assurance and control practices in the field and among laboratories used to provide analyses; and 3. designing rigorous statistical tests to evaluate multiple hypotheses. Because it is beyond the scope of this paper to discuss these in detail, helpful references are provided below[3,4,5]. However, operators should be aware that they will be inevitably accused of collecting biased information. Strict adherence to and documentation of objective sampling and analysis practices will help alleviate such concerns and protect against attack on cross-examination should a case actually go to trial.

Monitoring

The results of a baseline sampling and analysis program are used to design a monitoring program. Such a program will help operators detect early warning signs of impending problems that may be relevant to the three most common complaints attributed to CBM production: a. domestic water well quantity or yield; b. domestic water well quality, and c. the occurrence of free or dissolved methane. To be cost-effective, monitoring should be conducted in sensitive areas to determine if there are statistically meaningful trends in the value of environmentally sensitive parameters which may correlate with CBM activities. All of this information is vital to the causation defense that will form the centerpiece of most CBM litigations.

Regular monitoring helps establish how the range of values for any given aquifer parameter will vary as a result of either locally and regionally changing environmental conditions. Regular sampling of producing CBM aquifers also provide powerful means to assess reservoir continuity and to assess drainage patterns.

Conclusion

In view of the controversial environmental concerns and negative popular perceptions that have plagued CBM development everywhere, baseline studies are a relatively minor cost of doing business. Operators should consider including the right to perform baseline testing of a lessor's water wells in their mineral lease. Baseline studies should then be carefully planned prior to and during the lease acquisition phase, and implemented prior to and during production. At the very least, simple work should be performed that includes testing a lessor's water wells, noting mechanical problems, determining water yield, detecting the presence of methane prior to production, and noting anecdotal evidence of methane discharges at the surface. At best, a more detailed sampling and analysis of groundwater chemistry will help operators to understand environmental conditions prior to production.

Armed with the results of baseline studies, operators can better quantify the risks associated with production activities and prioritize the development of acreage positions. Delaying production in environmentally sensitive areas can provide ample time for establishing monitoring sites that can provide early warning signs of impending problems. Remediation costs will always be minimized when a program is in place to detect early warning signs and when contingency actions have been planned in advance. Operators who are sensitive to changes in the environment surrounding their producing fields are also in the best position to ward off needless litigation.

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