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**Guidance for
the Closure of Low-Threat Sites with
Residual Ground Water
Contamination**



**Colorado Department
of Public Health
and Environment**

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INTRODUCTION

Much has been learned about cleaning up ground water plumes since the advent of the Clean Water Act and other regulations that require remediation of contaminated water. Technologies used to address ground water contamination have evolved over the decades. During the 1970's and 1980's, pump and treat technology was the only widely used cleanup method for most sites. This era was followed by the advent of in-situ methods, which were widely used during the 1990s. Widespread implementation of those technologies was followed by awareness that monitored natural attenuation could address contamination at some sites.

The evolution of remedial technologies has been accompanied by a parallel evolution in thinking within regulatory agencies. In the early days, successful cleanup was measured by a strict adherence to numeric standards regardless of the hydrogeologic setting, suitability of the resource for future use or the presence of receptors that may be impacted by the contamination. As time progressed, it became apparent that there was a need for flexibility in achieving cleanup goals and that the threat posed by contamination should be factored into the decision process for addressing environmental remediation. By 2001, Colorado adopted Senate Bill 01-145, which created a statutory "environmental covenant", a mechanism for controlling future land and water resource uses at contaminated sites. Prior to this significant development, cleanup goals were intended to allow unrestricted use of property.

Over time, it has become clear that there are other factors relevant to ground water cleanup that may lead to the development of a risk management approach for some sites in Colorado. The last residues of recalcitrant compounds such as chlorinated solvents may not be practical to extract, or residual contaminants may be present in challenging hydrogeologic environments such as fractured rock or fine-grained aquifers. Additionally, there is a growing awareness that resources required to install and operate remedial systems in order to meet numeric standards in low-threat cases can be out of proportion to the threat actually posed to human health and the environment. These factors raise the question of whether the public good is served by requiring the expenditure of resources to actively cleanup low-threat sites.

Low-threat sites are defined as sites where contamination in an aquifer is limited in extent, is not spreading, where contaminant concentrations are declining via natural attenuation, poses no cross-media threat, the ground water is not being used, contamination does not reach surface waters, and the lack of exposure pathways results in a lack of threat to human health or the environment. These factors were discussed within in the Division and with outside parties, leading to the development of this guidance. This document identifies lines of evidence that would need to be satisfied before the Division could consider a proposal to terminate ground water remedial activities at a site undergoing cleanup prior to meeting all remediation goals.

State agencies with authority to oversee remediation of ground water contamination at facilities they regulate are required to implement water quality standards established by the Colorado Water Quality Control Commission, as defined in Regulation No. 41 (5 CCR 1002-41). It should be emphasized that the ultimate goal and expectation of any cleanup action, including the risk management-based approach being outlined in this guidance, is the eventual achievement these Colorado ground water standards ("CGWS"). Additionally, it should be emphasized that

the State considers the closure process outlined in this guidance to be of limited application, and used only when it has been demonstrated with scientific rigor that reasonable means, using the best available technologies, will not result in a significant improvement in ground water quality. This guidance will be applied only in situations where the expenditure of additional resources yields no increased benefit to human health and the environment and where all other conditions noted in this guidance are satisfied.

There are now three conditions under which the Division will make a formal decision to terminate the ground water remediation process. This decision is commonly referred to as a “No Further Action” or “No Action” determination (collectively referred to as “NFA” throughout this guidance):

1. The CGWS or health-based remediation goals approved by the Division in the absence of an established CGWS are met in all monitoring locations, so that the operation of remediation systems and monitoring programs are no longer necessary.
2. The Water Quality Control Commission approves a site-specific ground water standard to be met only at that specific location. Assuming the measured concentrations in ground water are all below this new site-specific standard, operation of remediation systems and monitoring programs may no longer be required.
3. If it can be demonstrated that the contamination in ground water poses little threat to human health and the environment and that the CGWS or other Division approved remediation goals in the absence of a CGWS will eventually be met within a reasonable timeframe, the Division may approve a request to terminate remedial activities and associated water quality monitoring requirements.

This guidance document focuses on the third scenario described above, and provides a framework for evaluating and demonstrating that these low-threat sites in Colorado may justify an NFA determination. However, any evaluation of whether or not a low-threat site warrants continued corrective action will occur within the context of all other characterization and/or remedial activities that have already been completed at the site. It is the Division’s expectation that the process of demonstrating that a ground water contamination plume at a site justifies an NFA determination even if residual contamination remains, will be accomplished by considering the following lines of evidence:

1. Adequate characterization of the site
2. Remediation of source areas
3. No exposure to contaminants
4. Demonstration of natural attenuation processes
5. Definition of the timeframe for achieving remediation goals
6. Ability to enact, implement and maintain institutional controls over time.

If a property owner believes their efforts at remedial actions have effectively satisfied the above criteria, these lines of evidence must be successfully demonstrated to the Division’s experts in a

submitted document, with appropriate scientific rigor using site data and sound technical reasoning. The sections that follow provide more detail on each of these evaluation criteria.

LINE OF EVIDENCE 1: ADEQUATE CHARACTERIZATION OF THE SITE

The site must be characterized to the extent necessary to understand the source of the contamination, its nature and extent, its fate and transport, and the potential for human or biotic exposure to the constituents of concern. Sufficient data should be available to develop a conceptual site model upon which to base corrective measures, and to assess any potential threat to human health and the environment. The following is a list of site-specific data and information that should be well understood and adequately documented, recognizing that the type and quantity of data needed is dependent on site-specific conditions:

- Nature and quantitative distribution of the source areas and ground water plume
 - Data collection in three spatial dimensions over time, where appropriate
 - Pollutant distribution within the environment (i.e., nature and extent)
 - Sources of pollution, primary and secondary
 - Source mass
 - Contaminant phase distribution and partitioning between soil, ground water, and soil gas
 - Physical and chemical characteristics of the discharge, including its potential for migration
 - Existing quality of ground water and surface water, including other sources of pollution and their cumulative impact on water quality
 - Potential for the pollutants to attenuate or degrade and the nature of the breakdown products
 - How all of these factors are likely to vary with time
- Site hydraulic, hydrogeologic, chemical, and geologic context
 - Hydrogeological characteristics of the site and surrounding land
 - Quantity of ground water and surface water and the direction of ground water flow, including preferential pathways
 - Hydrogeologic and geologic parameters and strata
 - Patterns of rainfall in the region and the proximity of the site to surface waters
 - Geochemical and biochemical data
 - Proximity and withdrawal rates of ground water users and the potential future changes to ground water flow based on these uses
 - Interaction of ground water and surface water
- Receptor and exposure pathway identification
 - All potential threats that these pollutants pose to human and ecological health, water resources, and the environment
 - Actual and potential exposure pathways and receptors
 - Actual and potential migration pathways
 - Persistence and permanence of any potential adverse effects

- Site uses
 - Present and probable future uses of ground water and surface water in the area. The potential for future ground water use should include review of all relevant information, such as: 1) USGS and Colorado Division of Water Resources water resources publications, 2) ground water protection plans and water classifications established by the Water Quality Control Commission, 3) local ground water management plans, 4) municipal water supply production and monitoring well locations, 5) domestic water well locations, and 6) local land and water use/supply plans.
 - Shallow ground water is generally assumed to be in hydraulic communication with a deeper aquifer when a substantial, competent aquitard is not identified or when data (i.e., aquifer pumping tests) are not available. Therefore, shallow ground water is assumed to have potential drinking water beneficial use unless a demonstration can be made that the shallow ground water is not reasonably expected to be used in the future or is not in hydraulic communication with a deeper aquifer that may be in use or have the potential to be used.
 - Planned current and future use of the site
 - Potential adverse effects (by contamination present or by imposed institutional controls) on approved local development plans

There is no quantitative method for determining whether a site has been adequately characterized. Division personnel will apply professional judgment in each case, factoring in such elements as: the cause of the suspected release, the chemicals of concern, the complexity of the site hydrology and hydrogeology, the magnitude of the problem, and the potential for future exposures.

A conceptual site model should be developed to integrate site characterization data and to guide both investigative and remedial actions. A site-specific conceptual model is a representation of the ground water flow and solute transport system over time. This model conveys what is known or suspected about contamination sources, release mechanisms, the fate and transport of the contamination, the site's biochemical and geochemical conditions and exposure pathways. It should take into consideration historic, current, and future conditions. The conceptual model may include a narrative, a diagram, and/or a chart. A conceptual model is not synonymous with "computer model" or "simulation model"; however, a computer/simulation model may be helpful in characterizing the site. The conceptual site model should constantly be evaluated during the site characterization process for data needs and consistency. It is important to collect field data to test the conceptual model, and not "force-fit" site data into a preconceived, and possibly inaccurate, conceptual representation.

LINE OF EVIDENCE 2: REMEDIATION OF SOURCE AREAS

Natural attenuation will be the primary mechanism by which qualifying low-threat sites will achieve the cleanup of residual contamination in ground water. It is the Division's expectation that the CGWS or health-based remediation goals approved by the Division in the absence of a CGWS will eventually be achieved at some future date. For many plumes (including chlorinated solvent and other organics), the natural attenuation rate will not be sufficient to overcome source loading without rigorous source removal and/or plume remediation to directly destroy/eliminate

pollutants and/or enhance natural attenuation rates. Therefore, the primary source area (waste and contaminated soil where the release occurred) and secondary source areas (contaminated ground water and formation materials causing re-entrainment) must be remediated to the extent practicable to ensure they are no longer acting as a source. More specifically, this includes remediation of residual contaminants entrained within or sorbed to soil, sediment, or bedrock that could continue to contribute to ground water contamination, to the extent that the CGWS or health-based remediation goals remain unattainable over time. Remediation of sources and plumes to the extent feasible is therefore required before natural attenuation can be considered a long-term remedy. A good faith effort must be made to remediate source area waste material still residing in the environment and any associated soil and ground water contamination using appropriate technologies that are considered feasible.

There may be rare situations where source identification and remediation could be problematic: the source may no longer exist or be of a size or in a location that makes finding and characterizing it difficult based on the available resources or technologies. Similarly, the magnitude and extent of contamination in the source area may be such that it is no longer impacting ground water quality to any significant degree. The Division has the discretion to decide whether the magnitude of the observed contamination in soil or ground water necessitates further investigation or active remediation, relying on the demonstrated reduction of contaminant concentrations in the plume as an indication of whether the original source of the contamination is still present or below levels of concern. In such cases, the ground water monitoring data could become the primary basis for determining whether natural attenuation is effective without active remediation.

If residual primary or secondary source contamination exists in soil at the time a request for NFA is made, monitoring results and or fate-and-transport modeling must be conducted under site-specific conditions. These studies must be adequate to demonstrate to the Division that any residual contamination will not leach into the ground water at concentrations that exceed the appropriate ground water standards. If the ground water is already contaminated, any residual source material that may still exist in the subsurface must not leach/diffuse at a rate that will impede natural attenuation processes from causing contaminant concentrations to decline at a speed that will allow for the timely achievement of the CGWS or health-based remediation goals approved by the Division in the absence of a CGWS.

Strong sorption of pollutants on soils, pollutant entrapment (e.g. dense non-aqueous phase liquids), or complex geology due to heterogeneity or fractures may make meeting cleanup objectives at some sites difficult to accomplish. Unless these types of sites are remediated to the extent needed to stabilize and eventually reduce the contaminant concentrations in ground water in a self-sustaining manner through natural attenuation, they will be ineligible for use of natural attenuation as a remedy for the purpose of an NFA determination.

LINE OF EVIDENCE 3: EVALUATION OF EXPOSURES

Evaluation of potentially significant impacts to water quality, human health, and the environment need to take into consideration the following, as applicable to the specific factual situation:

- The potential for health impacts caused by human exposure to waste constituents.

- Potential for future human health or environmental impacts based on changes to site use or use of surrounding properties.
- Existing or reasonably anticipated exposures through cross-media transfer. These may include:
 - volatilization into buildings
 - hydraulic connections to surface waters or other aquifers, or
 - agricultural or other non-domestic uses.
- The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents.
- Discharge to surface water relative to surface water standards, recognizing that a NPDES permit from the Water Quality Control Division is required for any such discharge.
- Impacts to downgradient ground water.
- A demonstration that residual contamination will not adversely affect present and future land and water uses, assuming reasonable engineering and institutional controls are employed to limit or prevent exposures and are maintained over time.
- The availability and feasibility of institutional controls to mitigate potential threats posed by the residual contamination. These controls must be durable over time.

If the constituents of concern pose a vapor intrusion threat, that pathway must be evaluated through direct testing of buildings above the ground water plume. Data must be provided showing that vapor intrusion is not occurring, i.e., measured values are equal to or below background or health-based concentrations (a hazard quotient of one for non-carcinogens or concentrations that represent an excess upper bound lifetime risk to an individual of 1×10^{-6} for carcinogens), whichever is higher.

LINE OF EVIDENCE 4: DEMONSTRATION OF NATURAL ATTENUATION PROCESSES

Using the site conceptual model as a foundation, it must be demonstrated to the Division that natural attenuation will in fact occur in order to further reduce contaminant concentrations in ground water. This may require analytical or numerical simulation of complex attenuation processes, the collection of additional biochemical or geochemical data, and site or laboratory studies. Natural attenuation processes may include: sorption, biodegradation, chemical reactions with subsurface materials, diffusion, dispersion, and volatilization. Answers to the following questions must be demonstrated to the Division:

A. Is the plume decreasing in size and magnitude?

The plume size in all dimensions and the plume concentration must be decreasing for natural attenuation to be considered as the sole remaining function following site closure (the plume is defined as the extent of contamination in ground water in all dimensions with concentrations in excess of the CGWS or other Division approved remediation goals in the absence of a CGWS). It must be demonstrated to the Division by ground water monitoring data and, if applicable, fate and transport modeling results, that the plume is shrinking under natural conditions (i.e., the natural flow regimen has been restored following any treatment of ground water). Several years worth of monitoring data may be required in order to perform a trend analysis that reliably shows improvements in water quality amidst seasonal and longer-term climactic changes. If monitoring data do not demonstrate that the size and concentration of a plume are decreasing, this may indicate that further source/plume remediation and/or monitoring are necessary.

For natural attenuation to be proposed as the remedy, declining concentration trends must not be dependent on the continued operation and maintenance of active remediation or containment systems. Any observed improvements in water quality must be *solely* attributable to natural attenuation uninfluenced by past or ongoing active remediation of the affected aquifer. Statistical methods may be applied to demonstrate decreasing trends if they are not readily apparent from the observed data. Description and justification of statistical methods should be provided.

Standard presentation methods should be used to show spatial and temporal trends of indicator parameters to demonstrate that the ground water plume is attenuating sufficiently to justify site closure. Standard presentation methods may include:

- Figures illustrating the current extent of ground water impacts, in excess of the CGWS or other Division approved remediation goals in the absence of a CGWS, using posted pollutant concentrations next to each well or point where measured.
- Figures comparing the current limits of pollution with its extent from prior time periods to illustrate plume stability, no migration, and plume retreat.
- Graphs showing current and historic pollutant concentrations and water levels versus time throughout the plume, including the plume boundaries.
- Graphs showing the current and historic pollutant concentrations versus distance in the direction of ground water flow.

B. Are monitoring data sufficient to characterize temporal variability?

Sufficient monitoring data should be available to show changes in water quality due to the natural, short-term ground water variability that is typically observed during the hydrologic cycle. If ground water conditions (e.g., depth, gradient, flow path) are expected to change significantly from year to year due to droughts, adjacent pumping, excess recharge, or other factors, then more frequent and/or additional monitoring may be necessary.

Monitoring is also necessary to evaluate potential increases (i.e., rebound) in contaminant concentrations following the discontinuation of active remediation methods. To fully evaluate post-remediation rebound, monitoring data should compare baseline (pretreatment) conditions with conditions during implementation of the remedy (e.g., performance monitoring data) and following completion (e.g., verification monitoring data). The objectives of verification monitoring are two-fold 1) demonstrate a return to natural/equilibrium conditions, and 2) demonstrate that concentrations have stabilized and that rebound will not occur.

The monitoring data should be sufficient to be used as the basis for prediction of the time for attenuation of the plume to levels that meet ground water standards. If data are not sufficient, then additional monitoring will be required.

C. Are there natural attenuation processes at work?

Natural attenuation processes must be demonstrated to be occurring at the site. This demonstration may include:

- Spatial and temporal trends in contaminant concentrations to demonstrate primary evidence of plume attenuation. Pollutants of concern must include all breakdown products generated during plume degradation.
- Spatial and temporal trends of hydrogeologic, geochemical and/or biological parameters to demonstrate indirectly the types of natural attenuation processes and the rate at which such processes will reduce contaminant concentrations. Biogeochemical parameters (e.g., dissolved oxygen, pH, electron acceptors, microbial populations, etc.) provide important evidence to show the potential for biodegradation throughout the plume. Indicator parameters should be evaluated and the meaning of their occurrence and distribution should be explained.
- Data from field or microcosm studies which directly demonstrate the occurrence of a particular natural attenuation process at the site should be presented.
- Results of fate and transport modeling. Any fate and transport model used to support the selection of natural attenuation must be capable of simulating the movement and degradation of contaminants in the aquifer over time and distance, taking into account attenuation mechanisms including biological, physical, and chemical processes. The model shall be appropriate for the site conditions and shall be a model that is peer-reviewed and widely accepted.

LINE OF EVIDENCE 5: DEFINITION OF THE TIMEFRAME FOR ACHIEVING REMEDIATION GOALS

Once it has been demonstrated that the contaminants are naturally attenuating throughout the plume and that the total mass of contamination will be reduced such that the CGWS or other Division approved remediation goals in the absence of a CGWS will be achieved in a reasonable

period of time, the predicted timeframe to achieve these standards or goals must be evaluated. The interpretation of reasonable period of time will differ for each site, based on threat to receptors and existing and future land use. What is reasonable should be evaluated in the context of the future ground water use, and if contamination is likely to adversely affect the use at that time. Evaluating the rate of cleanup and ground water use timeframes necessitates the use of best professional judgment based on site-specific data. Long-term monitoring of the natural attenuation may be necessary to estimate a time for cleanup.

Defining a reasonable timeframe is a complex and site-specific decision that does not permit establishing a generic time period that would be applied at all sites or facilities. Factors that should be considered when evaluating the length of time appropriate for remediation include:

- Proximity of contamination to receptors.
- Presence of sensitive receptors.
- Presence of threatened or endangered species or habitats.
- Classification of the affected resource (*e.g.*, drinking water source, agricultural water source) and value of the resource.
- Current and potential use of the aquifer, including proximity to private and public water supplies.
- Relative time frame in which the affected portions of the aquifer might be needed for future water supply (including the availability of alternate supplies).
- Geologic and hydrogeologic conditions.
- Magnitude, mobility and toxicity of the contamination.
- Uncertainties regarding the mass of contaminants in the subsurface and predictive analyses (*e.g.*, travel time for contaminants to reach points of exposure appropriate for the site).
- Reliability of institutional controls over long time periods.
- Public acceptance of the extended time for remediation

The timeframe needed for natural attenuation to achieve the CGWS or other Division approved remediation goals in the absence of a CGWS under the process outlined in this guidance may need to be extended when:

- Ground water is shallow, perched, or otherwise isolated.
- There are no abandoned wells and other vertical migration routes in proximity to the site.

- There is no current ground water use and the potential for future use in proximity to the site is low.
- Reliable institutional controls are in place that would tend to limit or preclude future use of the affected water resource.

Conversely, deeper ground water impacts, lack of a competent aquitard, proximity to nearby ground water resources presently in use, existence of vertical migration pathways, or ground water pumping scenarios may require meeting standards in a shorter timeframe.

LINE OF EVIDENCE 6: ABILITY TO ENACT, IMPLEMENT AND MAINTAIN INSTITUTIONAL CONTROLS OVER TIME

In 2001, Colorado adopted Senate Bill 01-145 (SB 145), which created a statutory “environmental covenant.” The law was amended in 2007 to add a second mechanism called a “notice of environmental use restrictions” or “restrictive notice.” This statute specifies that environmental covenants and restrictive notices are required for any “environmental remediation project” in which the “relevant regulatory authority” makes a “remedial decision” on or after July 1, 2001, that would result in either or both of the following:

- Residual contamination at levels that have been determined to be safe for one or more specific uses, but not all uses; or
- Incorporation of an engineered feature or structure that requires monitoring, maintenance, or operation or that will not function as intended if it is disturbed.

Covenants and restrictive notices are not formally required for “No Action” determinations on environmental remediation projects overseen by the Voluntary Clean-Up Program (VCUP), as noted in C.R.S. §25-15-101(4.5)(a-h). VCUP approval of a “No Action” petition is dependent on the applicant agreeing to limit the future use of a property for purposes identified in the petition. Failure to comply with the existing and proposed uses identified in the application effectively voids VCUP’s determination that the approved remedy is protective. Property owners may voluntarily choose to include in their VCUP application a proposal to prepare and file an environmental covenant as part of the site remedy, particularly if doing so reassures the Division that compliance with land use restrictions will be maintained for as long as they are deemed necessary.

Environmental use restrictions (environmental covenants, restrictive notices or land use commitments specified in the VCUP application) are required to ensure that remedial decisions are protective of human health and the environment. The statute defines “environmental use restriction” as a prohibition of one or more uses of or activities on specified real property, including drilling for or pumping ground water; a requirement to perform certain acts, including requirements for maintenance, operation, or monitoring necessary to preserve such prohibition of uses or activities; or both, where such prohibitions or requirements are relied upon in the

remedial decision for an environmental remediation project for the purpose of protecting human health or the environment.

An environmental covenant, restrictive notice or land use commitments specified in the VCUP application must be placed on properties with ground water levels exceeding the CGWS or other Division approved remediation goals in the absence of a CGWS to:

- restrict the use of contaminated ground water, and
- prohibit activities that may change environmental conditions and cause renewed movement or expansion of the plume, or unacceptable exposure to contamination.

It is the Division's expectation that the party requesting the no further action determination will perform much of the work needed to place the environmental covenant, restrictive notice or other Division approved institutional controls on the property. Tasks include, but are not limited to providing the Division with property information, such as a survey of the affected area and title insurance. Local municipalities must be contacted in order to verify that proposed use prohibitions are consistent with local zoning requirements. Stakeholders with interest in the property must be notified of the intent to create an environmental covenant or restrictive notice. Under C.R.S. § 25-15-321(5), the property owner must submit documentation to the Division certifying that it has notified those individuals having an interest in the affected property of such institutional controls.

Owners with ground water plumes that have migrated beyond their property boundary have the added burden of needing to place institutional controls on all affected properties if their intent is to seek an NFA determination from the Division. This could consist of having adjoining property owners agree to the placement of an environmental covenant or restrictive notice on their property. Under C.R.S. § 25-15-32(3)(b), the Division, with the assistance of the property owner, may negotiate an agreement with other governmental agencies to enact ordinances to restrict activities in offsite areas. Failure to place effective institutional controls on offsite properties overlying ground water plumes may be grounds for disapproving the request for an NFA determination.

Failure to implement, monitor and enforce institutional controls for a long-term remedy may trigger the need for continued active remediation and/or long-term monitoring to verify that the CGWS or other Division approved remediation goals in the absence of a CGWS will be met. If institutional controls are required as a condition of site closure, property owners must demonstrate to the Division that the proposed controls are robust, durable, and maintainable over time. Failure to do so could result in revocation of the NFA and cause the site to be reopened, including a resumption of ground water monitoring and/or remedial activities.

If, at some later date, it is demonstrated to the Division through additional ground water monitoring that ground water concentrations have fallen below the CGWS or other Division approved remediation goals in the absence of a CGWS, the property owner may choose to petition the Division to remove the institutional controls placed on the site. To process such a

request, the property owner needs to submit enough information to support their request for modifying or removing the institutional control.

PUBLIC NOTICE

Prior to formalizing a site closure decision, the property owner must notify building tenants and residents within the footprint of the ground water plume, in accordance with each State program's statutory and/or regulatory requirements. Division staff may choose to initiate and participate in community or public meetings to discuss the pending low-threat closure decision.

DOCUMENTATION

Any proposal to close a site using the NFA process outlined herein will require adequate documentation summarized in a comprehensive report that all of the lines of evidence noted in the previous sections of this guidance have been satisfactorily demonstrated. More data provided that reduces the uncertainty associated with leaving an unmonitored plume behind increases the Division's confidence that the residual contamination will pose little to no threat, that ground water quality will continue to improve and the CGWS or other Division approved remediation goals in the absence of a CGWS will eventually be achieved. Providing good documentation improves the chance of having the NFA proposal approved.

Data used to make decisions about all aspects of a NFA determination (site characterization, source remediation, plume behavior, natural attenuation, and reasonable time frame) should be generated within a documented framework, for example, the Unified Federal Policy Quality Assurance Project Plan (UFP QAPP) or EPA Data Quality Objectives (DQO). The burden of proof will be to demonstrate with sufficient and quality data that the desired outcome and objectives have been achieved.

A decision of whether to cease monitoring may be made by the Division in accordance with the Division's "Policy for a 'No Further Action' Determination When Contamination Remains Above The Colorado Ground Water Standards". The report provided to the Division documenting how all lines of evidence have been satisfied will become the basis for whether or not the NFA request is approved by the Review Board using the process outlined in that policy. The more complete and convincing the data provided, the greater the chance of having the Board approve the request.

OTHER OPTIONS IF A REQUEST FOR CLOSURE IS DENIED

In cases where not all lines of evidence are demonstrated to the satisfaction of the Division, site conditions are overly complex, or it is not feasible to cleanup the site in a reasonable timeframe, additional active remediation and/or monitoring may be required. The party responsible for the cleanup will be expected to perform one or more of the following:

- Additional site characterization to better identify/define the source areas and associated contamination and/or additional remediation using other remedial alternatives.

- If it is determined that it is technologically or economically infeasible to reasonably attain cleanup objectives after having taken all actions necessary to remediate the release, the responsible party has the option of continuing to monitor ground water quality on a periodic basis until additional work can be completed to help meet lines of evidence that are difficult to achieve or until the CGWS or other Division approved remediation goals in the absence of a CGWS are attained. At a minimum, this phase of the cleanup effort must demonstrate that pollutants have not and will not migrate beyond the boundaries of the existing footprint of the ground water plume. These sites will also require that an environmental covenant, restrictive notice or some other program specific institutional control be put in place to prevent future exposure to contamination. Considering the long duration monitoring under this option may necessitate, the Division may also require financial assurance to ensure that funding will be available for long-term remedial activities in the event the responsible party is no longer able to perform the required work.
- Seek a site-specific standard from the Water Quality Control Commission.
- Request that the Water Quality Control Commission reclassify the affected area to something other domestic or agricultural use that would allow the use of alternate concentration limits for cleanup purposes.

GLOSSARY

Active Remediation

Remedial techniques that rely on active measures to either treat or isolate contaminated soil or ground water in an effort to control or clean it up over an extended period of time. These in situ and ex situ techniques traditionally involve pumping up, injecting into, treating in situ or isolating the ground water. Such technologies include, but are not limited to, the following examples: pump-and-treat; passive and active non-aqueous phase liquid (NAPL) skimming; air sparging; dual-phase extraction; vacuum-enhanced NAPL and ground water recovery; any in situ treatment technique that requires the periodic addition of treatment agents or nutrients to aid in the destruction of chemical contaminants; containment barriers, regardless of whether they are created hydraulically or with physical barriers, such as slurry walls or sheet pile curtains.

CGWS

Colorado Ground Water Standard, as listed in “The Basic Standards for Ground Water”, Regulation 41 (5 CCR 1002-41).

Conceptual Site Model

A three-dimensional representation of the ground water flow and solute transport system over time. The model conveys what is known or suspected about contamination sources, release mechanisms, and the fate and transport of the contamination and includes the site's biochemical and geochemical conditions. It explains where pollutants are in the environment and the potential threats that these pollutants pose to human and ecological health, water resources, and the environment. The CSM is used to assess risks and threats to human and ecological receptors and water resources. It should take into consideration historic, current, and future conditions. The conceptual model is typically conveyed through written descriptions and is supported by maps, hydrogeologic cross-sections, tables, diagrams and other illustrations. A conceptual model is not synonymous with "computer model" or "simulation model"; however a computer/simulation model may be helpful for validating historic observations, for understanding and visualizing current site conditions, or for predicting future conditions. The conceptual site model should constantly be evaluated during the site characterization process for data needs and consistency. It is important to collect field data to test the conceptual model, and not "force-fit" site data into a preconceived, and possibly inaccurate, conceptual representation.

Environmental Covenant

A legal instrument that is recorded with the deed and runs with the land, to ensure that environmental use restrictions that are part of remediation projects are properly implemented and that engineered structures are protected and maintained, so that implemented remedies continue to be protective of human health and the environment for as long as any residual contamination remains a threat. An environmental covenant: establishes restrictions or conditions on the use of some or all of the property; requires maintenance of site conditions, engineering controls or response actions (e.g., response action equipment and water monitoring wells) to ensure protection of human health and the environment; provides disclosure of a release or threatened release of a hazardous substance, pollutant or contaminant; and obligates subsequent property owners/lessees to be bound by restrictions/ requirements related to contamination at the site.

Environmental Use Restriction

A prohibition of one or more uses of or activities on specified real property, including drilling for or pumping ground water; a requirement to perform certain acts, including requirements for maintenance, operation, or monitoring necessary to preserve such prohibition of uses or activities; or both, where such prohibitions or requirements are relied upon in the remedial decision for an environmental remediation project for the purpose of protecting human health or the environment.

Health-Based Remediation Goals

Constituent concentrations in a contaminated media that are protective of human health based on a specified land use scenario and set of exposure assumptions. For known or suspected carcinogens, the remediation goal should be at concentrations that represent an excess upper bound lifetime risk to an individual of 1×10^{-6} . For sites with multiple contaminants, the remediation goal should be set so that the risk posed by individual constituents does not exceed a 1×10^{-6} and where the cumulative (total) excess upper bound lifetime risk from all contaminants does not exceed a 1×10^{-5} . For constituents associated with adverse effects other than cancer, the remediation goal should be established at concentrations to which human populations, including sensitive subgroups, could be exposed on a daily basis without appreciable risk of negative effect during a lifetime. Such levels are interpreted as being equal to or below a hazard quotient of one. For sites with multiple contaminants or exposure pathways, the remediation goal should result in a cumulative hazard quotient (hazard index) equal to or less than one for all those constituents with similar critical endpoints.

Institutional Control

Institutional controls are instruments that contain legally enforceable restrictions, conditions, or controls on the use of real property, ground water, or surface water located at or adjacent to a facility, that helps minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. Institutional controls include restrictions, conditions, or controls enforceable by contract, easement, environmental covenants, restrictive notices, statute, ordinance, or rule, including official controls such as zoning, building codes, and official maps.

Low-Threat Closure

Low-threat closure is based on the understanding that cleanup standards can be met under natural conditions within a reasonable timeframe, once adequate source control and plume remediation are complete and considering site-specific conditions, the future land use, and the likelihood of and timeframe for actual beneficial use of the affected water resources. There is a high degree of confidence that pollutant toxicity, recalcitrance, and mobility, and the uncertainty associated with site characterization and remediation will not yield situations in the future that would endanger human health, surface water quality, and potentially usable ground water resources.

Natural Attenuation

The unenhanced natural processes that cause a reduction in mass or concentration of pollutants in ground water over time or distance from the point of release. The natural processes that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or ground water. These in-

situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.

No Further Action / No Action Determination

A determination made by the Department based upon an evaluation of the historical use of the site, or of areas of concern at that site, as applicable, and any other investigation or action undertaken showing that the site does not pose an unacceptable risk to human health and the environment and so requires no further activity. This assumes that either no contaminants are present at levels of concern or that any contaminants present at the site or that have migrated from the site have been remediated in accordance with applicable remediation statutes, rules and guidance and all applicable permits and authorizations have been obtained. This definition includes “no action determinations” made pursuant to C.R.S. 25-16-307 of the Voluntary Cleanup and Redevelopment Act when contamination does not exceed applicable promulgated state standards, contamination does not pose an unacceptable threat to human health and the environment, or for contamination that originates from a source on adjacent or nearby property.

Owner

The person or party who owns a facility or part of a facility on which a release has occurred and is now subject to remediation.

Plume

In ground water a plume is an underground pattern of contaminant concentrations created by the movement of ground water beneath or through a contaminant source. Contaminants primarily spread in the direction of ground water movement and to a lesser degree laterally via diffusion and mixing. The highest concentrations are typically found near the source of the release, concentrations generally decreasing as one moves away from the source.

Primary Source Area

Waste material and highly contaminated environmental media found in and immediately adjacent to the release point. It includes the following: activities that caused the release of waste and associated contamination into the environment, such as leaking tanks, leaking process equipment and the unintentional or intentional disposal of product or waste materials; all solid or hazardous waste that may have been discharged, deposited, injected, dumped, spilled, leaked or placed into or on the land or water; free phase contamination; soil that exhibits the hazardous waste characteristics of ignitability, corrosivity, reactivity, or toxicity as defined in 6 CCR 1007-3 Part 261 Subpart C; high concentrations of dissolved phase ground water contamination that by itself will be capable of continuing to act as a source to further degrade ground water quality if not remediated; high concentrations of contaminants sorbed to formation materials that by itself will be capable of continuing to act as a source to further degrade ground water quality.

Residual Contamination

Contamination which remains after an environmental cleanup was completed and approved.

Responsible Party

The person or party who either was responsible for causing the release of contamination to the environment or who has chosen to take on the responsibility of remediating the release of contamination under Division oversight.

Restrictive Notice

An alternative legal instrument that functions in the same way as an environmental covenant. It was developed for the purpose of addressing concerns expressed by federal agencies that the environmental covenant was an interest in property, rather than an exercise of the state's police power (the police power is the constitutional basis for all of the state's regulatory authority). The only difference between the two mechanisms is that the restrictive notice is signed only by the State, unlike an environmental covenant that is signed by both the State and party granting the environmental covenant to the Division.

Secondary Source Area

Environmental media, typically fine grained soil and fractured rock, located outside the primary source area that are also capable of degrading ground water quality for an extended period of time as a result of the retention of contaminants and their slow reverse diffusion. Where contaminated ground water has been in contact with formation materials, physical and chemical mechanisms such as adsorption and absorption results in the sequestration of pollutants deep into the particle matrix, the remediation of which is controlled by the overall rate of reverse diffusion (desorption).

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