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Defense-Related Uranium Mines Risk Screening Process

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Abbreviations

BLM	U.S. Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COI	constituent of interest
DOE	U.S. Department of Energy
DRUM	Defense-Related Uranium Mines
ft	feet
LM	Office of Legacy Management
µR/hr	microroentgens per hour
mrem	millirem
NEPA	National Environmental Policy Act
pCi/g	picocuries per gram
RSA	risk scoring assessment
V&V	verification and validation

1.0 Introduction

The Defense-Related Uranium Mines (DRUM) risk screening process provides a programmatic means for the U.S. Department of Energy (DOE) Office of Legacy Management (LM) to consistently evaluate and rank risk in order to identify the most significant hazards associated with a mine or group of mines in the DRUM Program. This process takes the results of the risk scoring assessment (RSA) through an evaluation procedure resulting in the final risk recommendation provided in a risk roll-up report. In collaboration with the appropriate land management agencies, the mines in the roll-up reports are grouped based on categories such as state, region, Field Operations Plan, or mining locality. The roll-up reports support collaboration on safeguarding mine-related physical hazards.


Note

In this document, the word "mine" refers to a mine in the DRUM Program. Any exceptions will be clearly identified.

The risk scoring conforms to the procedures in the *Defense-Related Uranium Mines Verification and Validation Work Plan* (DOE 2020) (V&V Work Plan); the results of the RSA are presented in the individual verification and validation (V&V) reports, which are the basis for the risk roll-up reports. The primary focus of the risk roll-up reports is to facilitate the review of a large amount of V&V information, to refine and recommend the final determination of the risk to identified resources, and to provide the basis for management decisions for the land management agencies. This document explains the risk screening process through which the risk roll-up reports are produced and the information used to determine the level of hazards and risks present at DRUM sites.

1.1 DRUM Program History

The National Defense Authorization Act for Fiscal Year 2013 mandated that DOE prepare a report on abandoned uranium mines. This report estimates that there are 4225 mines that provided uranium ore to the U.S. government between 1947 and 1970 for defense-related purposes. It concluded that some of the mines might pose a risk to human health and the environment, but the magnitude of the problem was unknown. Subsequently, DOE created the DRUM Program to evaluate the mines to address these data gaps. This program began in 2017.

1.2 Program Goals

DOE's DRUM Program is committed to collaborating with partner agencies and assisting with the safeguarding of the physical hazards associated with DRUM Program mines. To achieve this goal, a shared strategy for identifying physical hazards and assigning their priority is necessary. This risk screening process is designed to provide this assistance and is intended to focus on the salient information to support partner decisions. Once the partners have agreed on the physical hazards for an area, DOE will proceed with obtaining the necessary funding and continue partner collaboration for developing and completing the safeguarding project(s). This would include activities such as identifying necessary studies relevant to National Environmental Policy Act (NEPA) compliance, partner review and approval of special studies, preparing the NEPA decisions and LM's adoption of the NEPA decisions made by its partner agencies, and approving safeguarding designs and construction.

DOE does not have authority to participate in response actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Nonetheless, a primary program objective is to assist partner agencies with the data and ranking information about potential human health risks posed by long-term exposure to chemical or radiological constituents at mines. DOE's intent is to provide enough information to make risk-informed decisions about potential follow-up actions. DOE uses two sets of benchmarks based on progressively greater risk potential from chemical concentrations and a separate decision track focused on radium-226 to provide additional information. However, management decisions associated with long-term potential exposures are solely within the discretion of the partner agencies. An overview of the path forward after the risk recommendations are developed is shown in Figure 1, and the entire risk screening process is shown in Figure 2.

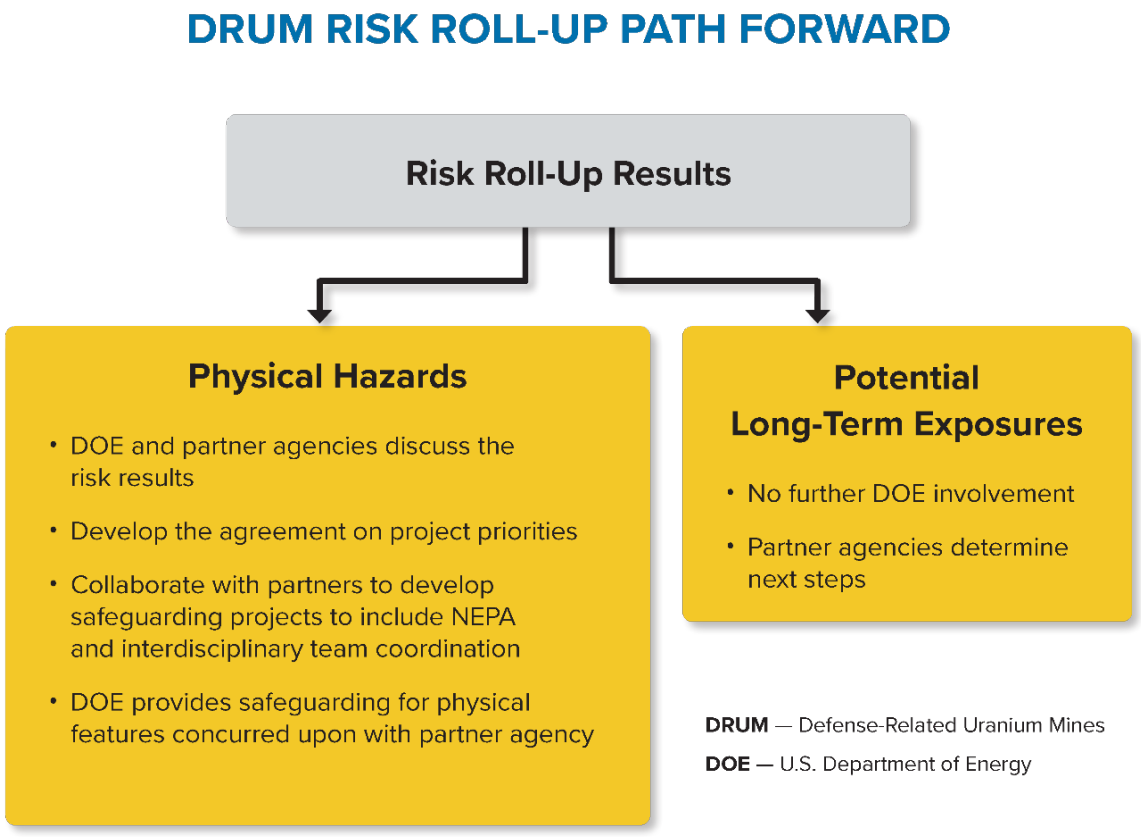

Figure 1. DRUM Risk Roll-Up Recommendations Path Forward

1.3 Overview of DRUM's V&V Process

The specific objective of the DRUM Program is to evaluate potential risks to humans or the environment by conducting V&V activities on individual mines. This V&V work is performed by LM and the Legacy Management Support contractor with involvement from collaborating partner agencies. V&V activities are described in detail in the V&V Work Plan.

These activities include reconciliation and inventory. Reconciliation activities involve reviewing historical records and researching the records of state and government agencies with abandoned

mine authority. Inventory activities include describing physical mine conditions, identifying mine-related features, assessing the physical hazards posed by each feature, evaluating ecological and environmental hazards, and evaluating the ease of public access to the mine. Also detailed in the DRUM V&V Work Plan are various objectives and methods for sampling with a primary focus on the mine's mechanically disturbed area and potential offsite migration areas if specific criteria are met. Examples of sample types include: waste rock samples (or soil samples), sediment shed samples, and surface water samples. In addition, a gamma radiation walkover survey delineates the radiological footprint of the mine.

The information collected about a mine is documented in a mine-specific V&V report which later serves as the basis for the information utilized in the risk screening process and ultimately as the basis for evaluating the risks posed by the mines presented in a risk roll-up report (Figure 2). These V&V results are presented in a manner that facilitates their integration into the risk screening process. The mine attributes are scored and ranked in the V&V report according to the RSA procedures in the V&V Work Plan. This process assumes a recreational-use scenario and includes decision point screening levels for gamma radiation (Brown 2017), metals in soil (BLM 2017; BLM 2019), and radium-226 exposure (Brown 2017). This recreational-use scenario assumes an exposure duration of 14 days per year for 26 years (BLM 2017). An overview of the DRUM RSA criteria is presented in Section 2.0.

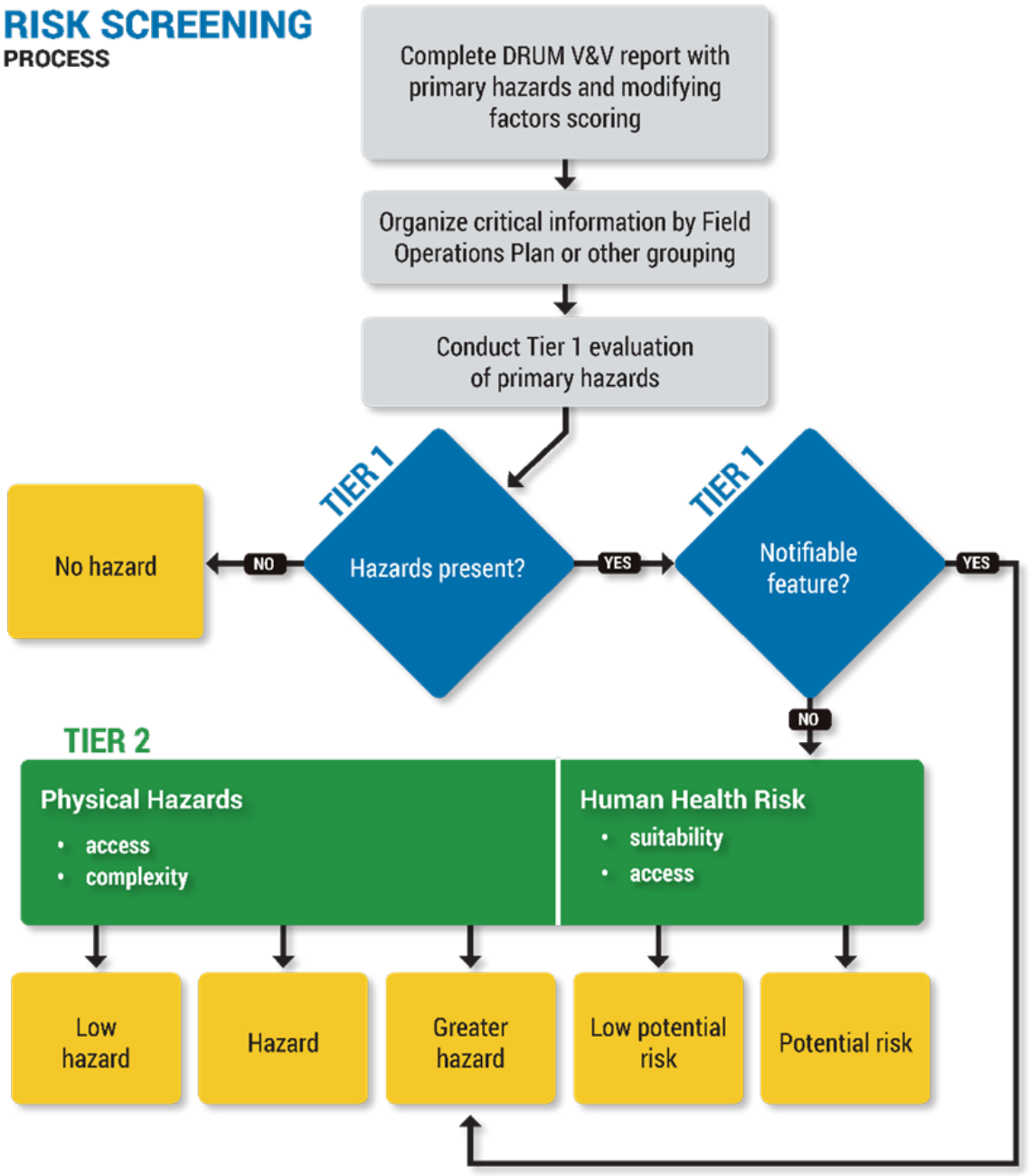

Figure 2. Risk Ranking Evaluation Process

1.4 Evaluation Process

The objective of the evaluation process, which culminates in the generation of a risk roll-up report, is to categorize (bin or bucket) a group of mines based on the information gathered during V&V activities. It is intended to be a starting point for collaboratively identifying those features needing safeguarding. Essentially, the process identifies which mines require no additional consideration, which mines would benefit from safeguarding, and those potentially needing further consideration for long-term exposure issues.

The overall approach is to screen the mines in greater degrees of detail in a succession of stages or tiers and to focus on binning the mines that are at the far ends of the hazard range; those mines that pose no hazard are at the low end of the range, and those that are considered an immediate threat are at the high end of the range. Mines that are in the middle of the range are further screened using several modifying factors (Tier 2). An overview of the risk screening process is presented in Figure 2.

Initially, mines are ranked based on the following possible hazards: physical hazards that are structures (e.g., an ore chute), physical hazards that are mine features (e.g., an adit or subsidence feature), and potential human health risks associated with exposure to gamma radiation, chemical constituents, or radium-226. This Tier 1 screening process (Section 2.0) scores each hazard or potential risk based on the primary screening criteria of the RSA (hazards receive scores of "high," "medium," "low," or "none"). For physical hazards, the DRUM Program uses two categories: structures and physical features (also referred to as nonstructures). Structures, which are above-ground mine-related constructed items (e.g., loadouts and ore chutes), are separated from excavated mine physical features (e.g., adits and shafts) because the partner agencies differ in their management philosophies for dealing with them. Because of this distinction in how the hazards will be managed, the screening process for structures ends at Tier 1; scores are recorded, and these features are not considered further in the Tier 2 screening. LM leaves the final ranking and management decisions regarding structures to the discretion of the partner agencies. The screening is also complete at Tier 1 for mines that do not possess physical hazards or potential human health risks. These are ranked as "no hazard" or "no potential risk." Mines with notifiable features, those that pose an imminent physical threat, are ranked as being a "greater hazard"; it is automatically assumed that these features will require some safeguarding, and therefore there is no need for further evaluation. All other mines proceed to Tier 2.

The Tier 2 evaluation (Section 3.0) uses modifying factors and essentially assesses the likelihood that risks posed by each hazard will be realized (e.g., the probability that someone will encounter an open adit or camp at a mine and be exposed to mine-related human health risks). Application of the modifying factors may lower or raise the initial mine scoring and ultimately its management priority. For physical hazards, the most important Tier 2 modifying factor is accessibility (e.g., if a mine can be accessed by a vehicle, it poses a greater threat than a mine that requires a strenuous hike to reach). For risks associated with potential exposure to gamma radiation, chemicals, and radium-226, the key modifying factor is the presence of a suitable area onsite for camping and the likelihood that someone could access the mine and want to remain there for a 2-week period (e.g., a mine with a suitable area for a hunting camp would pose a greater risk). The Tier 2 evaluation results in rankings of "low hazard," "hazard," or "greater hazard" for physical hazards and "low potential risk" or "potential risk" for chemical, gamma radiation, or radium-226 risks.

2.0 Risk Scoring Assessment Tier 1

The information in this section focuses on the first tier of the two-tiered evaluation process for mines included in the DRUM Program. The Tier 1 RSA is designed to provide an objective assessment of the severity of the mine hazards, and it is based on information from the individual V&V reports. The Tier 1 scoring is combined with additional mine characteristics (e.g., mine access) to arrive at the Tier 2 mine ranking. The goal in this prioritization approach is to put

mines that pose similar hazards into "bins" for management decisions. Information on the Tier 2 process and overall risk screening approach is provided in Section 3.0.

Tier 1 represents a decision point for mines with no physical hazards and mines which may require additional review in order for DOE and partner agencies to reach agreement regarding potential future action. This additional evaluation will ultimately determine which features will be safeguarded by DOE.

The Tier 1 scoring process identifies mines with no known hazards or potential risks and places mines with hazards or potential risks into high-, medium-, and low-priority categories. One objective of the Tier 1 process is to identify mines that are at opposite ends of the hazard spectrum: (1) those that have no physical hazards or potential human health risks and can likely be eliminated from further consideration and (2) those that pose clear physical hazards or potential human health risks (or both) and likely need action (i.e., those that are high-priority). All other mines are further screened in Tier 2.

As discussed below, physical hazards (structures and physical features [nonstructures]) and potential long-term exposures causing human health risks (gamma radiation, chemical constituents, and radium-226) at a mine are first designated as "none," "low," "medium," or "high" based on the severity of hazards present. Features that meet the definition of a "notifiable feature"[1] receive an automatic "high" score. The primary hazard scores provide an indication of whether hazards or potential risks are present or not. In the case where a mine has multiple features of a particular hazard type (e.g., multiple physical features), the score is based upon the feature posing the greatest hazard. The initial primary hazard scores can be adjusted by application of modifying factors using a multiple-lines-of-evidence approach to arrive at the final mine ranking in the Tier 2 evaluation. Modifying factors are (1) potential ecological and environmental impacts, (2) access and suitability criteria, and (3) the hazard complexity criterion. The modifying factors provide an indication of the likelihood that negative outcomes may occur as a result of these hazards. The scoring process is discussed below. The RSA tables are presented in Section 2.6.

2.1 Physical Hazard Evaluation

DOE found that diverse management philosophies and assumptions exist for mine structures. To best facilitate the recognition and condition of structures, the DRUM Program separates physical hazards into structures (above-ground mine-related features constructed of wood, metal, or concrete) and physical features (mine-related features resulting primarily from earthen excavation, which are also referred to as nonstructures). The severity of the hazards associated with both structures and physical features is recognized in the initial (Tier 1) scoring. However, only the physical features are retained for further risk evaluation and factored into the Tier 2 physical hazard ranking. The final ranking and management decisions for structures are left to the discretion of the partner agencies.

[1] Notifiable features are mining-related physical hazards that are located adjacent to or near well-traveled public roads and which could pose a significant and immediate threat to a visitor who encounters them. Notifiable features are identified and documented by the field teams and are reported to the appropriate land management agency and the LM project manager as soon as practicable.

A similar severity scale is used for ranking both structures and physical features (nonstructures). The score for each of these is based on the single structure or physical feature at the mine posing the greatest hazard (if there are multiple physical hazards, this is addressed under the complexity modifying factor). Only mines with a feature that could result in death or severe injury (e.g., an open vertical shaft greater than 10 feet [ft] in depth) are ranked "high" and receive a score of 3. If a mine has no features that pose a physical hazard greater than that of the surrounding topography, the mine scores a 0.

A "medium" score is given to mines that have physical hazards that are attractive to visitors and could result in a moderate injury (e.g., open portals, unstable structures). Mines that are categorized as "low" risk have features that could result in minor injuries (e.g., short falls, sprains) but are not particularly attractive to visitors and could be easily avoided (e.g., a highwall visible from upslope, vertical drill pipes extending above the ground surface). Agencies may want to reclaim these mines to return a site to more natural conditions, but they do not constitute a significant risk.

2.2 Human Health Risk Evaluation

The human health primary scores are based on gamma radiation surveys for the mine and on the composite analytical sample(s). Mines receive separate gamma radiation, chemical, and radium-226 scores, as these represent different types of exposure and different potential areas of exposure (i.e., sitewide exposure for exposure to gamma radiation versus exposure to the waste rock pile with the highest chemical risk ratio or highest radium-226 concentration).

DRUM Program–specific gamma radiation screening values of 64 microroentgens per hour (µR/hr) and 256 µR/hr above background were developed that equate to dose levels of 25 millirem (mrem) per year and 100 mrem per year for a hypothetical 2-week recreational (camping) scenario (Brown 2017). These dose levels represent U.S. Nuclear Regulatory Commission unrestricted use criteria and Atomic Energy Act of 1954 public exposure criteria for nuclear facilities and activities, respectively (Brown 2017). For purposes of scoring mines based on gamma radiation survey results, a lower threshold of 32 µR/hr above background (half the 64 µR/hr exposure level) is used, which equates to a 12.5 mrem dose for a 2-week camping scenario. The 32 µR/hr level coincides approximately with the U.S. Environmental Protection Agency's protective dose level recommendation of 12 mrem per year (EPA 2014) for unrestricted use at CERCLA sites. This additional benchmark of 32 µR/hr above background is intended to improve the certainty that a mine does not present a hazard from gamma radiation. If the average gamma radiation dose rate above background is below the 32 µR/hr screening level, the mine scores a 0. Mines with average gamma radiation dose rates between 32 µR/hr and 64 µR/hr, between 64 µR/hr and 256 µR/hr, and greater than 256 µR/hr receive scores of 1, 2, and 3, respectively.


Note

For scoring purposes, all dose rates listed are above background.

Analytical results from waste rock pile composite samples are compared with U.S. Bureau of Land Management (BLM) human health recreational screening levels (BLM 2017) and removal management levels (BLM 2019) for chemical constituents. Removal management levels were

developed by BLM to help determine when removal of mine-related wastes may be appropriate. Removal management levels are related to recreational screening levels, but removal management levels use a threshold risk for carcinogens of 10^{-4} and an equivalent hazard quotient of 3 for noncarcinogens. Recreational screening levels, on the other hand, are conservative and assume a threshold risk of 10^{-6} for carcinogens and an equivalent hazard quotient of 1 for noncarcinogens.

Risk ratios are calculated by dividing the analytical result from the composite samples by the recreational screening level and the removal management level for each analyzed chemical constituent of interest (COI). For each screening level, all individual ratios are summed to provide a cumulative risk ratio for each waste rock sample. A risk ratio of greater than 1 (individual or cumulative) is an indication that a mine could pose potential human health risks. Any necessary adjustment to background concentrations is part of the risk evaluation conducted to develop the risk roll-up reports.

Chemical risk scores are determined using the chemical risk criteria applied to the waste rock sample with the highest cumulative risk ratio. If the cumulative risk ratio for all constituents combined is less than 1 based on the BLM recreational screening levels, the chemical risk is assigned a score of 0. If the cumulative risk ratio is greater than 1 and less than or equal to 14, the chemical risk is assigned a score of 1. If the cumulative risk ratio is greater than 14 for the recreational screening levels but less than 1 for the removal management levels, the chemical risk is assigned a score of 2. If the cumulative risk ratio for the removal management levels is greater than 1, the chemical risk is assigned a score of 3.

A 2020 update of the human health risk evaluation process added the concentrations of radium-226 to the evaluation process. Since the program began, the concentrations (measured in picocuries per gram [pCi/g]) of radium-226 have been recorded as part of the waste rock sampling, and informal screening information has been included in the V&V reports. However, radium-226 was added as a separate evaluation category because elevated levels have been documented at a small number of mines that are potential candidates for removal actions by the partner agencies. Overall, LM determined that adding this separate evaluation would also allow the partner agencies to make better risk-informed decisions to address the elevated radium-226 concentrations discovered at several mines. Brown (2017) evaluated concentrations of radium-226 in soil that would correspond to the 25 mrem per year and 100 mrem per year benchmarks assuming the same recreational use scenario, which are 37 pCi/g and 147 pCi/g, respectively. In addition to these two thresholds, a third one was added that is analogous to the removal management levels used to evaluate the chemical constituents in waste rock piles. This level, which is 294 pCi/g, assumes a 1-week camping scenario on the waste rock pile with the highest radium-226 concentration at a mine. If the highest radium-226 concentration at a mine is less than the 37 pCi/g screening level, the mine receives a score of 0. Mines with radium-226 concentrations between 37 pCi/g and 147 pCi/g, between 147 pCi/g and 294 pCi/g, and greater than 294 pCi/g receive scores of 1, 2, and 3, respectively.

2.3 Ecological and Environmental Hazard Evaluation

The ecological and environmental scoring approach ranks both physical hazards and the presence or absence of potential radiological and chemical risk pathways. The two types of hazards are given separate scores. If a given physical feature poses multiple hazards (e.g., to both special-

status species and migratory birds), the feature is assigned only the highest score (i.e., a single feature is not scored twice).

A mine will receive a high score in the physical hazard category if evidence of a special-status species or designated critical habitat for a threatened or endangered species is present within 0.25 mile of the mine and there is a potential physical hazard to that species. Special-status species are federally listed or proposed for listing as threatened or endangered; state-listed as threatened, endangered, or sensitive; identified as sensitive by BLM, the U.S. Forest Service, or tribal authorities in the district in which the mine is located; or listed as U.S. Fish and Wildlife Service Birds of Conservation Concern for the region in which the mine is located. Special-status species are noted in the risk ranking tables but only receive a score when combined with a potential hazard.

The objective of the risk pathway portion of the ecological and environmental hazard evaluation is to provide an indication of whether a pathway may exist for the exposure of ecological receptors to mine-related contamination, primarily through surface water or the food chain. A gamma radiation measurement greater than 64 μR/hr is used as an indicator of mine-related contamination for both radioactive and nonradioactive contaminants that could indicate a complete pathway. A single elevated measurement may result in a nonzero score in this category because it is an indicator that a pathway could exist; it is not a determination that a pathway does exist. A mine receives a nonzero score if there is evidence of contamination migration from the disturbed area (a potential pathway could exist) or if contamination from the mine has reached surface water (a pathway is assumed to exist). A mine also receives a nonzero score if contamination is present on a waste rock pile with significant amounts of edible vegetation because this also indicates the potential for a pathway. A zero score indicates that no significant risk pathways are likely to exist at the mine. A nonzero score indicates that a closer evaluation of the chemical and radiological data may be needed before concluding that the mine does or does not present a potential ecological threat.

2.4 Access and Suitability Evaluation

Scores in this category reflect mine visibility (i.e., attractiveness), accessibility, and suitability. Separate scores are given for access and suitability. Access is relevant to both physical hazards and human health risks, with greater accessibility resulting in a higher probability that the hazard can lead to adverse impacts. The suitability score is relevant in modifying the human health risk ranking for potential long-term exposure to gamma radiation, chemical constituents, or radium-226; if a mine would likely not be used as a campsite because it is of inadequate size or it has unsuitable topography, then the assumed exposures are unlikely to occur.

Higher access scores are assigned to mines with greater ease of access; for example, a mine that is accessible by a two-wheel-drive vehicle scores higher than one that requires a hike. A mine gets a single access score based on the easiest method of accessibility (i.e., it does not get a score for both accessibility by vehicle and accessibility on foot). If mine features are readily visible and considered to be an “attraction,” they are also scored higher (features increase the likelihood that people could visit the mine). A high score in the access category is only important when coupled with a physical hazard or potential human health risk; if no hazards are present, the access score is irrelevant. However, if physical safety hazards or potential human health risks are present, the access score is important in determining the likelihood that they will be encountered.

Suitability is an indication of whether a mine site can be used for the camping scenario. A mine needs to be of adequate size and appropriate topography for a camping scenario to be feasible. Direct evidence that a mine has been used for this purpose is considered to be a better indicator of this use than the distance to residences or other populated places. A mine receives the highest suitability score if there is direct evidence of camping (e.g., the presence of a fire ring). A lower score is assigned if a site has suitable conditions for a campsite but shows no evidence of human use. A score of 0 means that the mine site is too small for exposures to be feasible or that topography precludes this use (e.g., no flat or cleared areas to set up a tent).

2.5 Complexity Evaluation

The complexity factor is a measure of the degree of additional physical hazards at a mine apart from the main physical hazard. This factor is mainly used to determine if an initial hazard ranking should be elevated due to the presence of multiple hazards. If numerous physical hazards are present, the chances are increased that a visitor could be injured, and the mine might be elevated in priority over a mine with fewer hazards.

2.6 Risk Scoring Assessment

Primary Hazards			
PHYSICAL HAZARD EVALUATION—PHYSICAL FEATURES			
Criteria	**Potential Impacts**	**Priority Score**	**Comments and Observations**
At least one physical feature that could cause serious injury or death to people (e.g., an open shaft, a subsidence that is open to the subsurface, or an unstable adit that can be easily entered)	3		
At least one physical feature that could cause a moderate injury to people and may be attractive to visitors or not easily seen (e.g., a stable adit that can be easily entered or an unstable adit that is difficult to enter)	2		
At least one physical feature that could cause a minor to moderate injury but is not attractive to visitors and could be easily avoided (e.g., a prospect, a 3 to 6 ft trench with steep sides but that can easily be seen from a distance, or a deep water-filled feature)	1		
No inherent hazards; no increased injury potential compared to the surrounding area	0		
SUM Physical Hazard Evaluation Score 3 = High, 2 = Medium, 1 = Low, 0 = None			
PHYSICAL HAZARD EVALUATION—STRUCTURES			
Criteria	**Potential Impacts**	**Priority Score**	**Comments and Observations**
At least one structure that could cause serious injury or death to people (e.g., a large unstable structure such as an ore chute or ore bin that may collapse)	3		
At least one structure that could cause a moderate injury to people (e.g., a building or large unstable structure of moderate height)	2		
At least one feature that could cause a minor to moderate injury but is not attractive to people (e.g., a building or unstable structure that is <6 ft in height)	1		
No structures or increased injury potential	0		
SUM Physical Hazard Evaluation Score 3 = High, 2 = Medium, 1 = Low, 0 = None			
LONG-TERM EXPOSURE—RADIOLOGICAL			
Gamma Radiation Risk Criteria	**Potential Impacts**	**Priority Score**	**Comments and Observations**
Mean gamma radiation survey result for the total disturbed area of the mine that is greater than 256 µR/hr above background	3		
Mean gamma radiation survey result for the total disturbed area of the mine that is greater than 64 and less than or equal to 256 µR/hr above background	2		
Mean gamma radiation survey result for the total disturbed area of the mine that is greater than 32 and less than or equal to 64 µR/hr above background	1		
Mean gamma radiation survey result for the total disturbed area of the mine that is less than or equal to 32 µR/hr above background	0		
SUM Radiological Human Health Risk Evaluation Score 3 = High, 2 = Medium, 1 = Low, 0 = None			
LONG-TERM EXPOSURE—CHEMICAL			
Chemical Risk Criteria			
The cumulative risk ratio is greater than 1 for the BLM removal management levels	3		
The cumulative risk ratio is greater than 14 for the BLM risk screening levels but less than or equal to 1 for the BLM removal management levels	2		
The cumulative risk ratio is greater than 1 and less than or equal to 14 for the BLM risk screening levels	1		
The cumulative risk ratio for all COIs is less than or equal to 1 for the BLM risk screening levels	0		
SUM Chemical Human Health Risk Evaluation Score 3 = High, 2 = Medium, 1 = Low, 0 = None			
LONG-TERM EXPOSURE—RADIUM-226			
Radium-226 Risk Criteria			
The concentration of radium-226 is greater than 294 pCi/g	3		
The concentration of radium-226 is greater than 147 and less than or equal to 294 pCi/g	2		
The concentration of radium-226 is greater than 37 and less than or equal to 147 pCi/g	1		
The concentration of radium-226 is less than or equal to 37 pCi/g	0		
Human Health Evaluation Score: highest score of the three criteria will be used to rank the human health risk 3 = High, 2 = Medium, 1 = Low, 0 = None			

Modifying Factors			
ECOLOGICAL AND ENVIRONMENTAL RISK EVALUATION			
Physical Hazard Criteria	**Potential Impacts**	**Priority Score**	**Comments and Observations**
A special-status species or designated critical habitat for threatened or endangered species is present on or within 1/4 mile of the mine (yes or no; list if yes)	Y or N[a]		
One or more mine features (e.g., vertical openings, vents) are present that could cause serious injury or death to a special-status species	5		
One or more mine features (e.g., vertical openings, vents) are present that could cause serious injury or death to a migratory bird	3		
One or more mine features (e.g., vertical openings, vents) are present that could cause serious injury or death to a species that does not have special status	1		
No inherent physical hazards to wildlife compared to surrounding area	0		
SUM Ecological and Environmental Physical Hazard Score 5 or greater = High, 3 to 4 = Medium, 1 = Low, 0 = None			
Pathway Hazard Criteria			
Mine-related contamination[b] has reached surface water	3		
Mine-related contamination[b] has been transported (by wind or water) outside of the mine disturbed area but has not reached surface water (e.g. a sediment shed is present)	1		
Vegetation attractive to wildlife is present in quantities greater than 10% cover on a waste rock pile that has the potential for contamination[b]	1		
No potential pathways for contaminant migration evidenced by sediment shed or vegetation	0		
SUM Ecological and Environmental Pathway Hazard Score 3 or greater = High, 2 = Medium, 1 = Low, 0 = None			

Notes:

[a] If "No," mine cannot receive a score of 5 (i.e., "high").

[b] A gamma radiation measurement greater than 64 µR/hr above background is used as an indicator of mine-related contamination for both radioactive and nonradioactive contaminants.

ACCESS AND SUITABILITY EVALUATION			
Access Criteria	**Potential Impacts**	**Priority Score**	**Comments and Observations**
Mine is readily accessible from a maintained road using a standard two-wheel-drive passenger vehicle or by walking	3		
Mine is not accessible by standard two-wheel-drive passenger vehicle; mine is accessible by four-wheel-drive vehicle or a utility task vehicle	2		
Mine is inaccessible by four-wheel-drive vehicle or utility task vehicle	0		
Mine access requires an easy to moderate hike of <1 mile across relatively flat terrain	2		
Mine access requires a hard hike (e.g., bushwhacking, grade greater than 10% slope, no defined trail, or >1 mile)	0		
Mine feature is visible from a maintained road that is passable by a vehicle, particularly if an attractive nuisance feature is present	3		
Mine is partially visible from a maintained road	2		
Mine is not visible from a maintained road	0		
SUM Access Score 5 or greater = High, 3 to 4 = Medium, 2 = Low, 0 = None			
Suitability Criteria			
Sign of human use associated with camping onsite (e.g., fire ring, abandoned tent stakes, or other related equipment) is present from the period after the mine was abandoned	6		
Sign of human visitation (e.g., trash, vandalism, tire tracks) is present from the period after the mine was abandoned	3		
No sign of human use or visitation is present from the period after the mine was abandoned	0		
The total disturbed area is greater than 2 acres and includes an area that would be suitable for camping. Note the estimated size of the total disturbed area and its mean gamma radiation value in the comments and observations.	3		
The total disturbed area is 1/4 to 2 acres and includes an area that is suitable for camping	2		
The total disturbed area is either less than 1/4 acre or contains no areas that are suitable for camping	0		
SUM Suitability Score 6 or greater = High, 3 to 5 = Medium, 2 = Low, 0 = None			

COMPLEXITY EVALUATION			
Complexity Criteria	**Potential Impacts**	**Priority Score**	**Comments and Observations**
Mine is extensive with more than one open mine entry, has vertical walls or steep slopes that could cause injury, or unstable structures. Note the number of hazardous mine features and structures in the comments and observations.	3		
Mine with one open mine entry and some other features that could cause injury (e.g., steep slopes, unstable structures). Note the number of hazardous mine features and structures in the comments and observations.	2		
No reason to increase the score based on mine complexity (e.g., no subsurface access and only minor disturbances that are not likely to cause injury)	0		
SUM Complexity Score 3 = High, 2 = Medium, 0 = Not applicable			

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3.0 Tier 2 Evaluation and Risk Roll-Up Reports

The DRUM Program risk screening process is designed to provide the land management agencies with an initial ranking of mines and delivers this information in two complementary levels of reporting: mine-specific V&V reports and project-level roll-up reports. Mines are ranked based on physical hazards and potential human health risks. All DRUM Program information is presented in individual V&V reports which provide detailed site maps, photographs, and chemical and radiological screening results. After all V&V reports within a given project area have been completed, the pertinent information is consolidated into a single comprehensive risk roll-up report that addresses the mines within that project area. This roll-up report facilitates the screening and evaluation of large amounts of information by tabulating multiple screening factors to enable the agencies to identify potential hazards and risks. When additional site-specific scrutiny is needed, the reviewer can reference individual mine V&V reports for more detailed information.

DOE will recommend risk rankings in the roll-up report for the land management agency's review and use. Based upon the agency's review, DOE will incorporate any necessary ranking modifications to their agreement on which physical hazards DOE will safeguard. The actual safeguarding process will be detailed in formal agreements with the partners and will cover items such as activities needed to comply with NEPA, funding, and approvals of safeguard designs. The risk roll-up process is described below.

3.1 Process Overview

The risk screening process being conducted by DOE uses a two-tiered approach, which was shown in Figure 2. Tier 1 was described in Section 2.0, and this section provides the details on how the risk scoring information is evaluated in Tier 2.

At the start of the Tier 2 evaluation process, mines without hazards or potential risks (i.e., mines with Tier 1 scores of "none" or 0) receive a "no hazard" rank, while those having notifiable features (and a Tier 1 score of "high" or 3) receive a "greater hazard" rank. Those mines are eliminated from further evaluation at this step. The remaining mines are subjected to a Tier 2 evaluation of modifying factors to develop risk ranking recommendations for physical features (nonstructures) and potential human health risks. "Low hazard" mines are sufficiently low-risk that no additional DOE involvement is likely to be necessary, and some action is generally justified for mines ranked as "hazard" and "greater hazard." DOE is committed to safeguarding the relevant physical hazards agreed upon with the partner agencies. The mines designated as "potential risk" because of elevated gamma radiation, chemical constituent concentrations, or radium-226 concentrations have the greatest potential for additional assessment at the discretion of the land management agencies. This additional assessment work is outside the authority of DOE. The Tier 2 decision process is described in further detail in Section 3.2 below.

3.2 Tier 2 Decision Process

As noted above, Tier 1 of the screening approach only evaluates whether a hazard or potential risk is present at a given mine and assigns each hazard a score based on its severity ("low," "medium," or "high" for physical hazards [nonstructures] and potential human health risks). The RSA tables (Section 2.6) are used to record site characteristics and determine Tier 1 scores. A

score of "none" for either physical hazards or potential human health risks means that no additional evaluation is needed. A notifiable feature automatically results in a "greater hazard" ranking for physical hazards, and no further evaluation is required. All other mines that include any primary hazards or risks with a "low," "medium," or "high" score move on to the Tier 2 evaluation. If a mine has multiple physical features, the Tier 1 physical feature hazard score is based on the feature that presents the greatest hazard.

The Tier 2 evaluation is an estimation of the likelihood that a hazard or risk will actually pose a threat to a site visitor. Several modifying factors are considered, with the most important being site access. Mines that can be accessed by vehicle are much more likely to pose a risk than those that are very difficult to visit. For physical hazards, only a one-time visit is required for injuries to occur; therefore, evidence of visitation is a strong indicator that these risks can occur, even if a mine is not readily accessible by vehicle.

In the Tier 2 evaluation, a major consideration for human health risks is whether or not a mine is likely to be used for the assumed exposure scenario of camping. For a site to be considered a potential human health risk, there must be a likelihood that it will be used for this purpose for a prolonged period of time (2 weeks per year for 26 years). Evidence of visitation alone is not sufficient to establish that a given site may present this type of risk; the evidence must also indicate that prolonged use has occurred (e.g., a campfire ring). If the site is not suitable for camping (e.g., if the waste rock pile is on a steep slope that precludes its use as a campsite), then the contamination is not available to receptors for an extended period, and ease of access to a mine is of lesser importance. Another consideration for mines with high gamma radiation, chemical risks, or radium-226 concentrations is the potential for offsite migration of contaminants, particularly if there is potential for migration onto private property. The migration potential is evaluated for mines with high gamma radiation levels, chemical concentrations, or radium-226 levels, and the results are noted during the Tier 2 evaluation.

Physical hazards: Mines with scores of "none" or 0 from the Tier 1 screening are assumed to require no additional risk management activities. Mines at which at least one hazard is present move on to the Tier 2 evaluation. Mines with Tier 1 hazard scores of "low" pose a relatively minor threat and are automatically assigned a Tier 2 rank of "low hazard." Whether these mines have features that warrant safeguarding is a decision which requires partner agency review in order to reach agreement. An example of a "low hazard" mine is one where the feature with the greatest potential to cause injury is a shallow trench or a prospect. While "low hazard" mines do not pose a significant risk to visitors and may require no action, the "low hazard" ranking indicates that the mine has at least one unreclaimed mining feature. However, modifying factors, such as ease of accessibility, will not affect the minor risks posed by a "low hazard" mine. Consequently, "low hazard" ranks are not adjusted during the Tier 2 process; site characteristics are noted, and mines are binned into the "low hazard" category.

It is assumed that mines with "medium" or "high" hazard features will likely require some action, and these mines need to be prioritized for agency planning purposes. Mines with Tier 1 scores of "medium" or "high" (Figure 3) may have their hazard ranking adjusted during the Tier 2 evaluation based on modifying factors. For example, a mine with a "medium" physical hazard score that is difficult to access and has no signs of visitation may receive a Tier 2 rank of "low hazard."

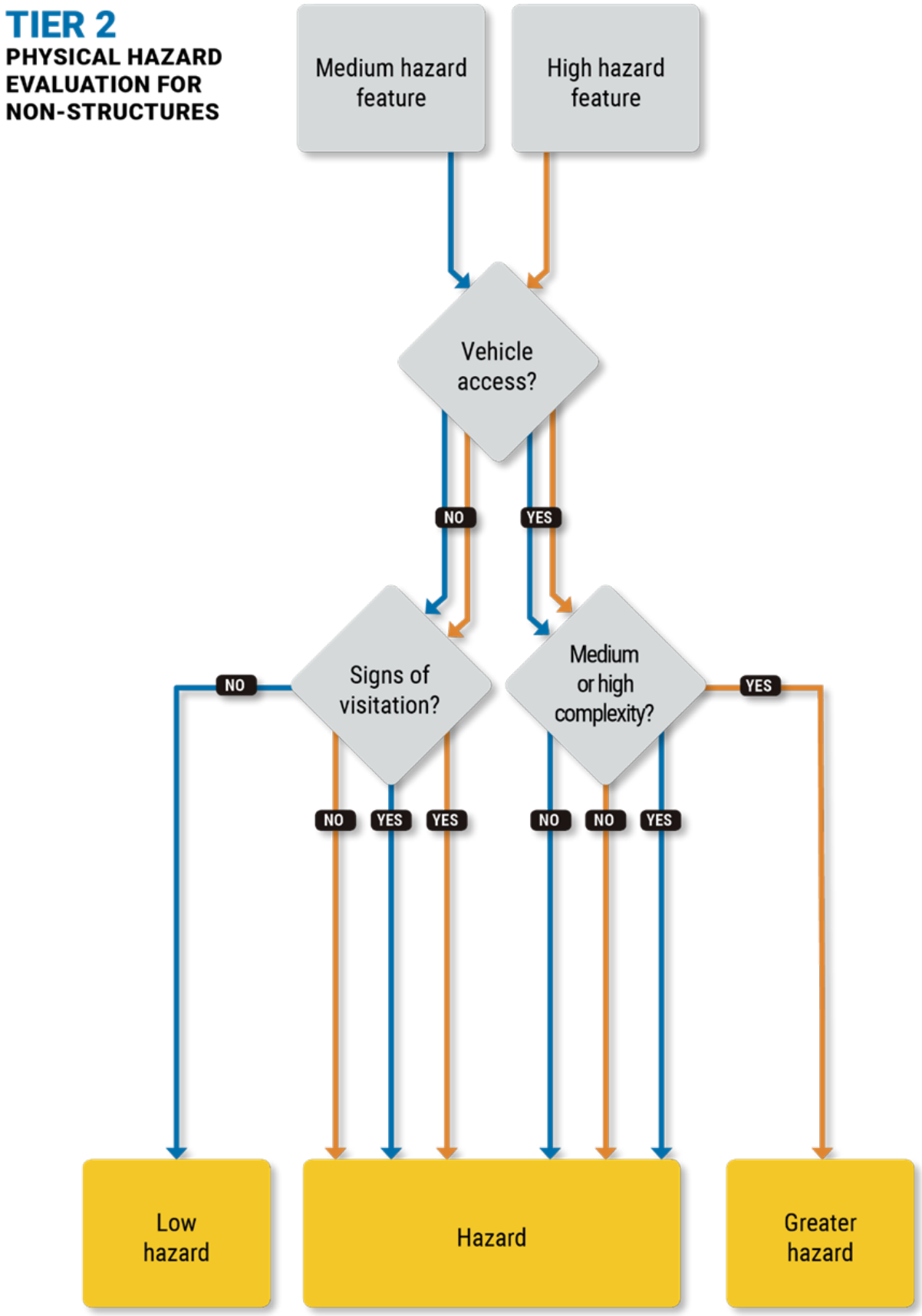

Figure 3. Tier 2 Physical Hazard Evaluation for Physical Features (Nonstructures)

Radiological hazards: Gamma radiation exposure (which, it is assumed, could potentially occur over the entire disturbed area) requires only onsite presence; it does not require ingestion or inhalation of contaminated soils. Most mines with low radiation levels (average gamma radiation levels less than or equal to 64 µR/hr above background; see Section 2.0) will qualify as "low potential risk" sites.

Low radiation mines that are particularly accessible and suitable for camping qualify as "low potential risk" or "no potential risk" depending on whether site-specific characteristics could pose a risk, such as the presence of sizeable areas of elevated gamma radiation (Figure 4).

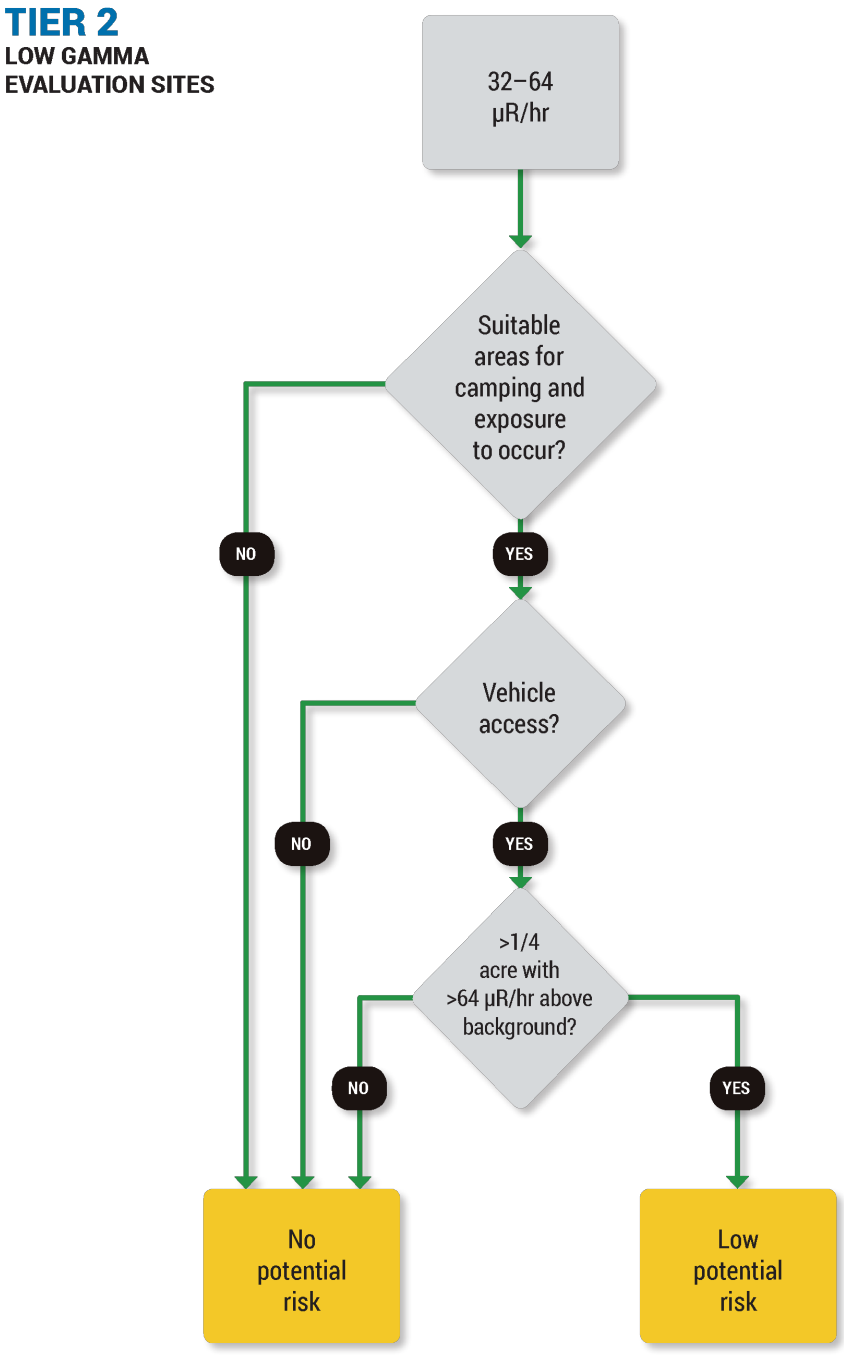

Figure 4. Tier 2 Low Gamma Radiation Evaluation Sites

Higher radiation mines (e.g., average gamma radiation levels >64 µR/hr above background) that are not suitable for camping or have no features to encourage visitation can be considered to pose "low potential risk" on this basis. For higher radiation mines with characteristics suitable for use, the rank is increased to "potential risk," and at the discretion of the partner agency, the site may require additional management decisions (Figure 5). Higher radiation mines will be evaluated for migration potential and the results noted. If there is a potential for migration, this will be noted as a flag for the partner agencies, though it will not factor directly into the Tier 2 recommended ranking for the mine.

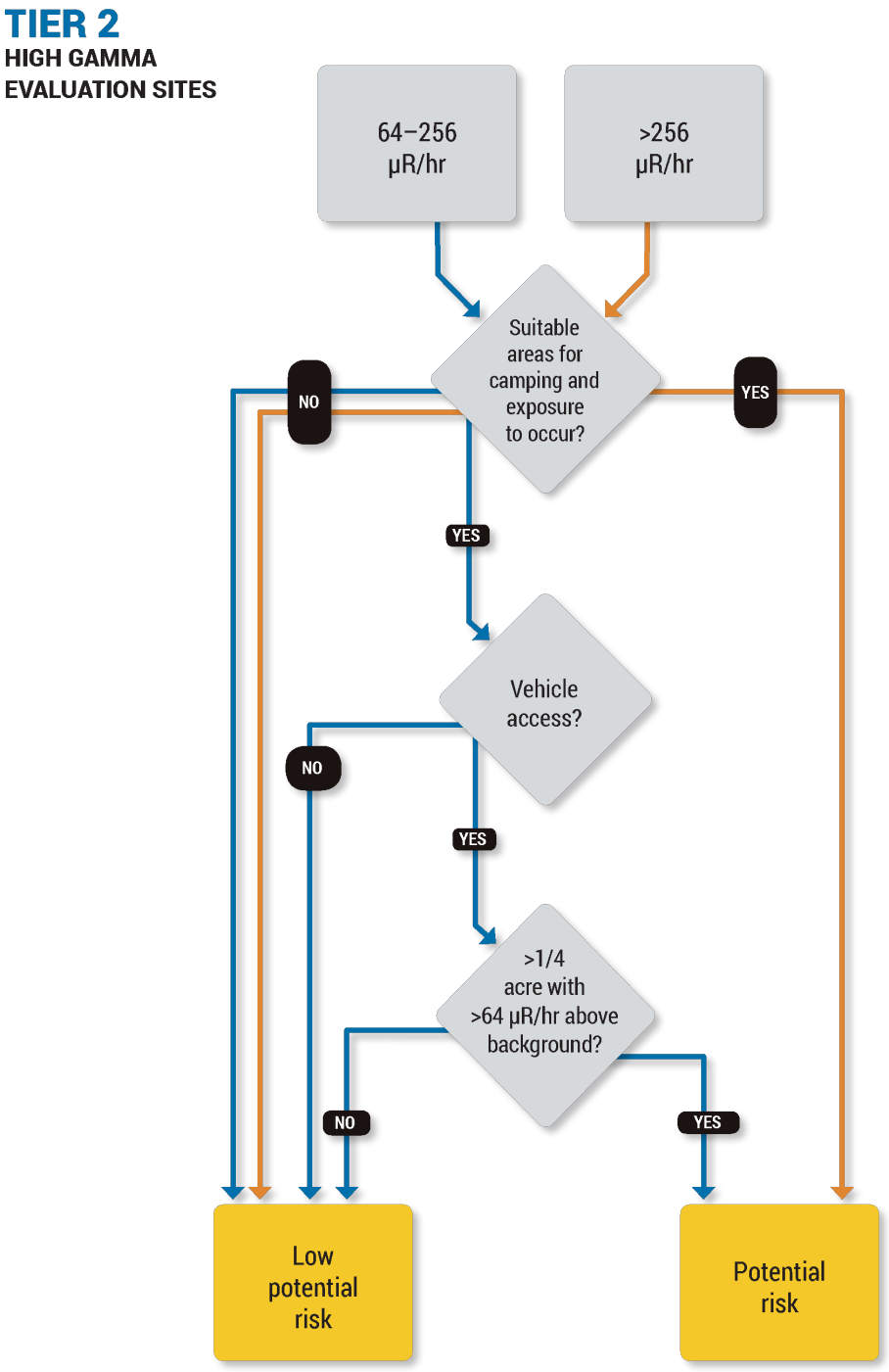

Figure 5. Tier 2 High Gamma Radiation Evaluation Sites

Chemical human health risks: Exposure to chemical constituents associated with mining requires not only the onsite presence of a receptor but also that contaminated soil be ingested or inhaled during the site visit. It is unlikely that chemicals at low concentrations will pose a threat, especially if contamination is concentrated in steep waste rock piles as opposed to being distributed across suitable camping areas. The potential for risks increases if concentrations are very high; when risk ratios exceed 14, harmful exposure could occur in as little as 1 day per year over a 26-year period (or a total of 26 days over a lifetime).

For lower concentration mines (cumulative risk ratios >1 to ≤14) the background concentration is first subtracted for the Tier 2 screening. If the background-adjusted cumulative risk score for each of the waste rock piles is less than 1, the mine is downgraded to a "no potential risk" ranking. DOE considers that mines with "low potential risk" chemical rankings will likely require no additional management activities; however, if sites are easily accessible and suitable for camping, the rank is increased to "potential risk," and the mine could be considered, at the discretion of the partner agency, for additional management decisions (Figure 6).

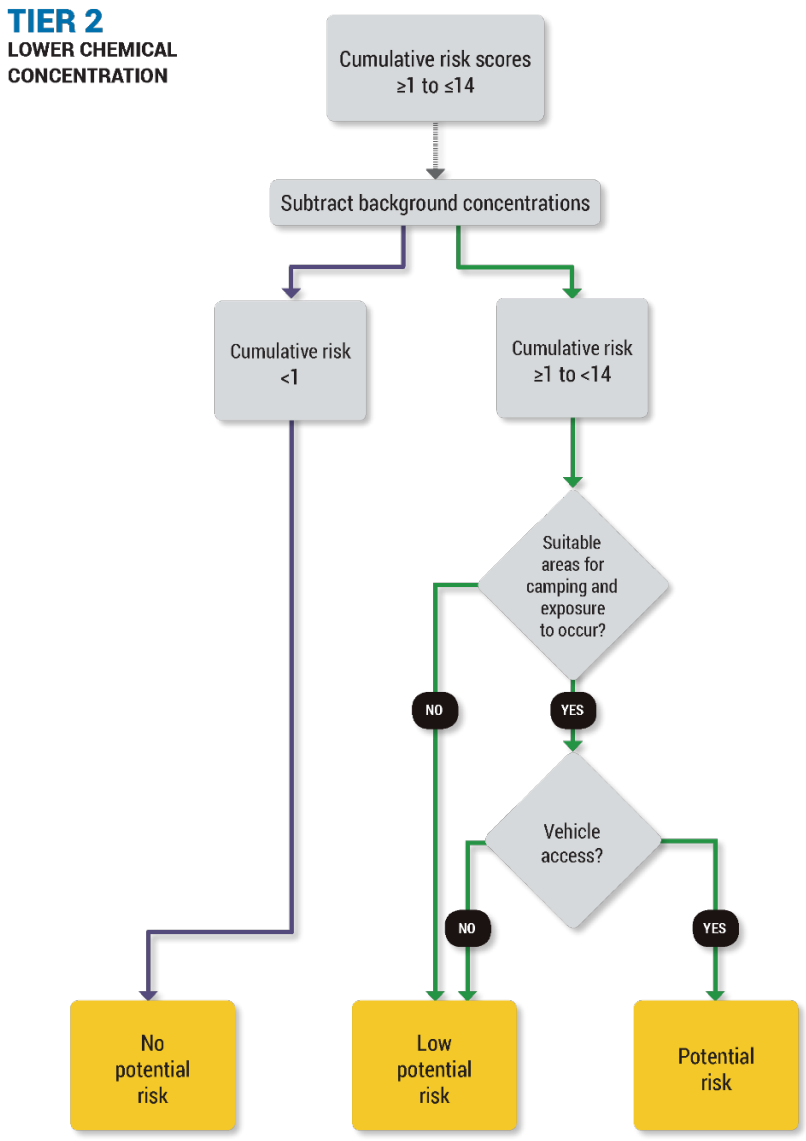

Figure 6. Tier 2 Lower Chemical Concentration

Higher chemical concentration sites with characteristics suitable for use may require additional management decisions by the partner agency (Figure 7). Higher chemical concentration sites will be evaluated for migration potential and the results noted. If there is a potential for migration, this will be noted as a flag for the agencies, though it will not factor directly into the Tier 2 recommended ranking for the mine.

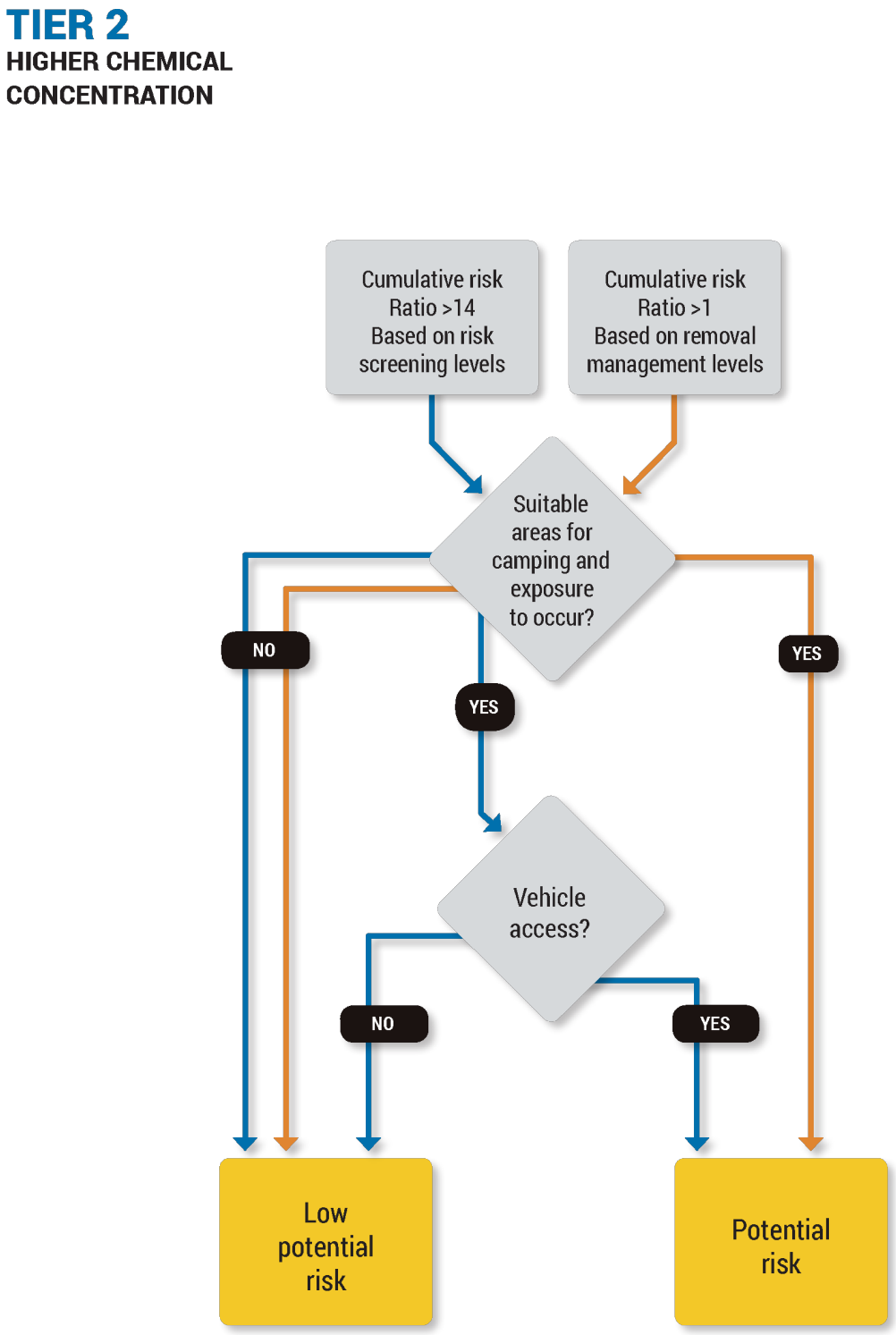

Figure 7. Tier 2 Higher Chemical Concentration

Radium-226 human health risks: Exposure to radium-226 requires that contaminated soil be ingested or inhaled. A major health impact for radium-226 is associated with the gamma radiation that occurs with this compound, which is addressed separately for the entire disturbed area. The radium-226 evaluation is based on the analysis results from the waste rock sample with the highest concentration at a mine. This separate analysis has been added because elevated concentrations are being observed at a small number of mines in the program, and partner agencies may consider additional management decisions based solely on elevated radium-226 concentrations.

For lower concentration sites (at which radium-226 concentration is >37 to ≤147 pCi/g), modifying factors such as suitability for camping and vehicle access are applied (Figure 8). If the background-adjusted radium-226 concentration for each of the waste rock piles is less than 37 pCi/g, the mine is downgraded to a "no potential risk" ranking. If there are no suitable areas for camping and exposure to occur, or the site is not accessible by vehicle, the site is ranked "low potential risk." If the site has suitable areas for camping and exposure to occur in addition to vehicle access, the mine is ranked "potential risk."

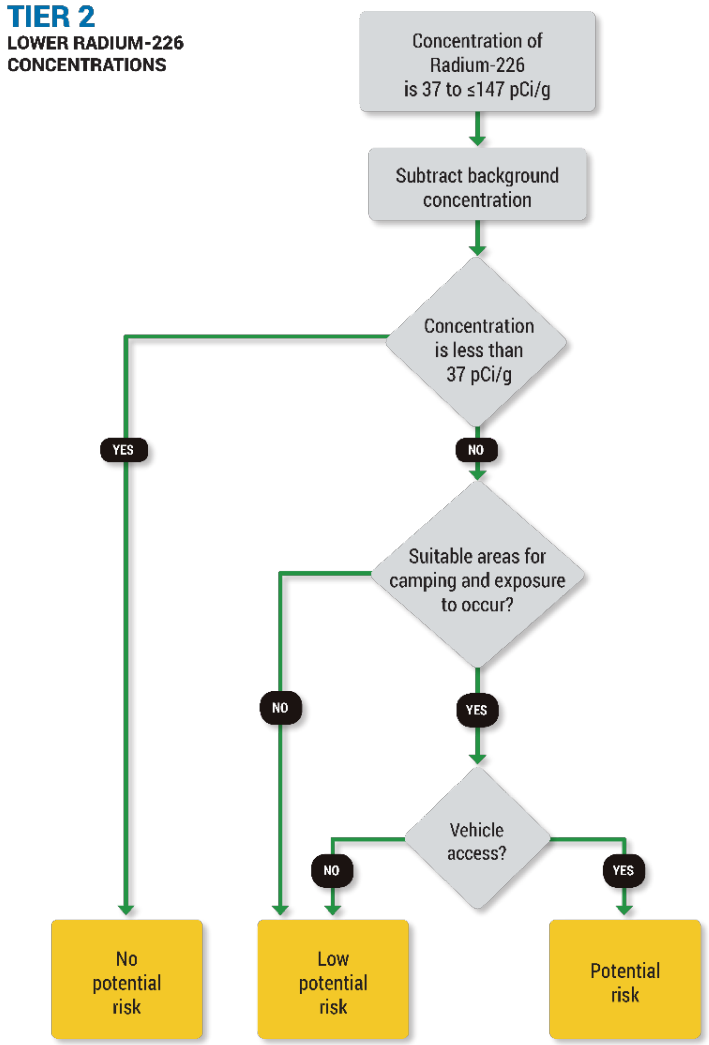

Figure 8. Tier 2 Lower Radium-226 Concentrations

Similarly, for higher concentration mines (at which the concentration of radium-226 is >147 pCi/g), modifying factors such as suitability for camping and vehicle access are applied (Figure 9). If there are no suitable areas for camping and exposure to occur, the site is ranked "low potential risk." In the case of sites where concentration is greater than 294 pCi/g, if the site has suitable areas for camping, it is ranked as "potential risk." For sites with concentrations between 147 and 294 pCi/g, if the site has suitable areas for camping to occur and is accessible by a vehicle, the mine is also ranked "potential risk."

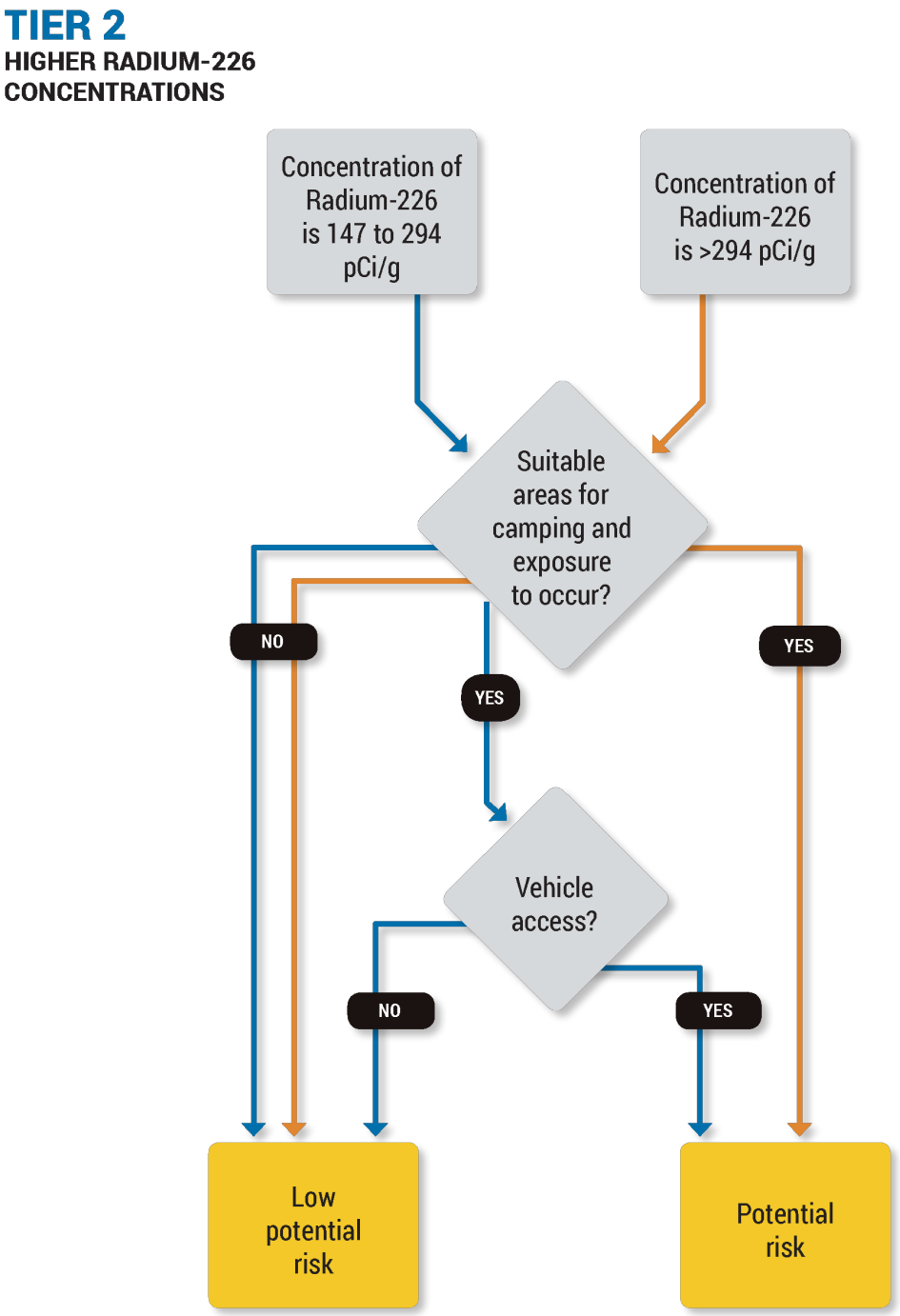

Figure 9. Tier 2 Higher Radium-226 Concentrations

4.0 References

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