



REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 4.19

(Task WM 408-4)

GUIDANCE FOR SELECTING SITES FOR NEAR-SURFACE DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE

A. INTRODUCTION

The purpose of this regulatory guide is to provide guidance on screening areas to identify a site or sites for near-surface disposal of low-level radioactive waste (LLW). Section 61.50, "Disposal Site Suitability Requirements for Land Disposal," of 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," lists technical requirements for the site; Subpart C of Part 61 lists performance objectives that must be met by the disposal facility. The purposes of screening are to identify a site or sites that have a high potential for meeting the site suitability requirements of paragraph 61.50(a) and to help ensure that the performance objectives of Subpart C will be met.

This regulatory guide provides guidance for conducting a site screening investigation. It is anticipated that much of the data required for site screening can be obtained from published and open file information and aerial photographic interpretation. Only limited onsite studies are anticipated at the screening stage.

This regulatory guide provides guidance on site selection to be conducted in steps with the goal of finding a site that has a reasonable likelihood of being licensed. The site characterization program, on the other hand, is designed to produce all the information necessary to support the license application. Information on site characterization requirements for a license application is provided in NUREG-0902, "Site Suitability, Selection and Characterization";¹ Regulatory Guide 4.18, "Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive

Waste";¹ and NUREG-1199, "Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility."¹

Applicants are encouraged to meet informally with the NRC technical staff at any time during the precense stage to discuss license application requirements, performance objectives, or technical requirements of 10 CFR Part 61. These informal discussions will streamline the review process and reduce overall costs to the applicant.

Any information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Part 61, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 61 have been cleared under OMB Clearance No. 3150-0135.

B. DISCUSSION

The technical site suitability requirements for near-surface LLW disposal are presented in paragraph 61.50(a) of 10 CFR Part 61. These requirements address specific conditions that could affect long-term site stability and waste isolation. The site suitability requirements may eliminate from consideration land that has certain unfavorable hydrologic, geologic, land use, and demographic conditions that could adversely affect the site and its environs.

In evaluating sites for LLW disposal, it is important that a reasonable effort be made to select candidate sites with natural conditions that will maintain radionuclide releases to the general environment as low as is reasonably achievable. The NRC staff considers the long-term contribution of the natural conditions of the site essential in protecting the general population against releases of radioactive material. The effectiveness of

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other measures such as design features, waste form, waste packaging, and institutional controls is assumed to decrease with time after site closure.

The NRC staff expects that the natural conditions of any proposed near-surface LLW disposal facility will contribute favorably to the isolation of LLW and to the stability of the disposal site after closure. Although it is unrealistic to expect total isolation or site stability in the long term, it is expected that careful selection of a site will limit the potential for radionuclide leaching, provide long pathways to minimize potential radionuclide releases, prevent erosion and inundation of the disposal site to minimize active maintenance, and avoid areas in which detrimental human activities are occurring. It is expected that the concepts in the technical requirements in § 61.50 will help the applicant meet the performance objectives for effluents (§ 61.41) and long-term stability (§ 61.44). Such careful site selection, along with equally careful consideration of the facility design, operation, and closure requirements of 10 CFR Part 61, will ensure that the overall performance objectives of 10 CFR Part 61 will be met and that the health and safety of the public will be protected.

C. REGULATORY POSITION

The performance objectives of Subpart C of 10 CFR Part 61 were established to define a level of safety for near-surface disposal of LLW. The technical requirements of Subpart D were established to help ensure that the performance objectives are met. Demonstrating compliance with the site suitability requirements of paragraph 61.50(a) will specifically contribute to achieving the performance objectives of §§ 61.41 and 61.44.

1. CONSIDERATION FOR SITE SUITABILITY

The following should be considered when screening a region of interest to identify a site for characterization. NUREG-0902 contains information that will assist in demonstrating compliance with the site suitability requirements.

1.1 Capable of Being Characterized (Paragraph 61.50(a)(2))

The ability of a site to provide long-term isolation of waste should be demonstrated by using models and other analyses based on the characteristics of the site. A site that is being considered for LLW disposal must be capable of being analyzed, characterized, and modeled. This suggests identifying the individual components of the site, identifying the physical characteristics that make each individual component unique, and preparing a general representation of each site component to enable predictions of site performance. Although site characterization is not necessary for screening, there are some general concepts that should be considered to provide reasonable assurance that site characterization can be fulfilled.

Sites that are geologically and hydrologically simple and contain processes that occur at consistent and

definable rates are preferred over complex sites. For modeling, input assumptions must be valid (representative) for all site conditions. If a complex site condition is not included in a model, it must be demonstrated that the condition either has no effect on site performance or can be accounted for by using a conservative parameter.

1.2 Population Distribution and Land Use (Paragraph 61.50(a)(3))

The candidate site should be located in an area of low population density where the potential for future population growth is estimated to be quite limited. The candidate site should be at least 2 kilometers from the residential property limits of the nearest existing urban community (NUREG-0902, p. 6). However, the exact distance to the nearest residential property may vary depending on local land use and demographic conditions.

Applicable State and local land use plans and regulations (including zoning ordinances) should be fully evaluated to be sure that there are no conflicting regulations or conflicting plans for development in the vicinity of the site. Residentially zoned or planned land uses are considered to be conflicting uses and should not exist or be planned in the vicinity of the candidate site. In addition, local and State authorities should be consulted for information on planned highway construction in the vicinity of the site to be sure that no highways are planned that would interfere with the operation of the site. It is also important to determine whether or not there will be adequate access to the site in terms of future highways and land use.

1.3 Natural Resources (Paragraph 61.50(a)(4))

Published or open file information on natural resources should be evaluated to determine the potential impact on the site if natural resources were to be exploited. Examples of natural resources to be considered include metallic and nonmetallic minerals and ores; fuels such as peat, lignite, and coal; hydrocarbons including gas, oil, tar sands, and asphalt; geothermal resources; industrial mineral deposits such as sand and gravel, clays, aggregate sources, shales, and building stone; timber; agricultural ground; or surface waters.

Areas should be avoided if they contain natural resources in quantities or of such quality that future exploitation could affect waste isolation. Care should be taken not to eliminate areas from consideration by using a blanket type of screening criteria, for example, eliminating all areas with coal deposits. This could eliminate otherwise suitable sites in a broad geographic area even though many of the coal deposits that exist are insignificant as economically recoverable resources.

1.4 Site Must Be Well Drained (Paragraphs 61.50(a)(5) and 61.50(a)(6))

A 100-year floodplain, coastal high-hazard areas, wetlands, or areas where flood velocities could cause

damage to the disposal facility are not suitable for waste disposal. In general, significant flood inundation and high water velocities can be expected in poorly drained areas, the floodplains of major rivers, and areas situated near hydraulically steep streams or arroyos with large drainage areas. Such areas should be avoided in the siting of LLW facilities.

Additionally, projected land uses (such as urbanization or other factors that increase runoff potential) should be evaluated to determine the effect of such changes on flood levels, flood-water velocities, and the overall impacts of flooding on site stability.

A waste disposal site should not be located in an area where the natural ground slope is steep. Runoff from intense local precipitation may cause damage to the waste disposal unit or to diversion channels constructed to divert overland flow around the site. Intense rainfall could be a determining factor in the stability of the site. Even though the upstream drainage areas may be minimized, steep slopes could produce high water velocities that could be difficult to mitigate.

In general, sites should not be located in areas where extensive hydraulic design features will be needed to provide flood protection or erosion protection for the site. The NRC staff considers that natural conditions of the site, by virtue of topography, elevation, and location, should provide the principal contribution to site stability. While some minor hydraulic engineering designs will usually be necessary, extensive hydraulic designs should be avoided because (1) they may lose their effectiveness over time without maintenance and (2) they may not provide an adequate degree of confidence in predicting their long-term performance or in meeting the long-term stability requirements of § 61.44.

1.5 Depth to Water Table (Paragraph 61.50(a)(7))

Areas with a known or suspected high water table should be avoided. A disposal site should be sufficiently above the water table so that ground-water intrusion, perennial or otherwise, into the waste will not occur. In accordance with paragraph 61.50(a)(7), waste disposal should not be permitted in the zone of fluctuation of the water table.

Hydrologic analyses that may be helpful in determining depth to the water table and seasonal fluctuation include surface and subsurface studies. Surface studies may include geologic maps and stratigraphic cross sections, aerial photo interpretation, vegetation maps (especially useful in arid regions), and surface-based geophysical exploration techniques. Subsurface studies may include water-level data from new or existing wells, lithologic logs, and bore hole geophysical logging. Regional data regarding the hydrologic setting can be obtained from a variety of U.S. Geological Survey and State publications, including geologic and topographic maps, professional papers, and bulletins. Other sources include the U.S. Department of Agriculture and U.S. Weather Service.

1.6 Ground-Water Discharge (Paragraph 61.50(a)(8))

Areas are not suitable for LLW disposal if ground-water discharge features such as springs, seeps, swamps, or bogs are present. The NRC staff prefers long flow paths from the disposal site to the point of ground-water discharge in order to increase the amount of time for decay of the radionuclides, increase the hydrodynamic dispersion within the aquifer, and increase the likelihood of retardation of reactive radionuclides in the aquifer.

Hydrogeologic analyses can be conducted by reviewing open file reports, maps, and low-level aerial photographs. In addition, site visits during wet seasons may be helpful in identifying ground-water discharges.

1.7 Tectonic and Geomorphic Processes (Paragraphs 61.50(a)(9) and 61.50(a)(10))

A site in a tectonically active area may have unfavorable conditions. Volcanism and hydrothermal activity may be unfavorable. Potentially unfavorable factors might include active faults as evidenced by earthquake activity. Correlation of earthquake activity with known faults and tectonic provinces should be considered in the evaluation of site suitability. Analysis of known or suspected tectonic activity during relatively recent geologic time, especially during the Quaternary, should be conducted to evaluate the likelihood that the site suitability requirements will be met.

Selected sites should not exhibit karst terrain or other evidence of subsurface settlement and dissolution. Examples of these features include sink holes, disappearing streams, and subsurface cavernous weathering in carbonate and evaporite rocks.

Sites should be avoided where eolian, fluvial, or colluvial processes may adversely affect performance of the disposal facility and its long-term stability. Processes such as dune migration, gulying, river channel migration, or landsliding and debris flows on unstable slopes can impair the operation of the site, affect the long-term stability and performance of the disposal units, and impact design features for hydraulic protection of the disposal units. The extent and rates of these natural processes are often difficult to predict, and sites where such phenomena are likely should be avoided if possible.

In addition, sites should be located in geologic and topographic settings that are naturally resistant to water and wind erosion and flooding. For example, a site must not be located on a 100-year floodplain, coastal high-hazard area, or wetland. Ideally, a site should be located near a drainage divide and must be generally well drained.

Regional data regarding the tectonic and geomorphic settings of proposed sites can be obtained from a variety of U.S. Geological Survey and State publications, including geologic and topographic maps, professional

papers, and bulletins. Other sources include the U.S. Department of Agriculture and U.S. Weather Service. Site-specific data are likely to require field study.

1.8 Adverse Impacts from Nearby Facilities (Paragraph 61.50(a)(11))

A candidate site should not be located near any facilities or activities that could adversely affect the ability of the site to meet the performance objectives of 10 CFR Part 61. In addition, a candidate site should not be located near facilities that could mask the site monitoring program.

State and local land use plans should be evaluated to determine the potential for future facilities and activities to adversely impact the proposed disposal facility.

2. SITE SELECTION PROCESS

The generic site selection process outlined below provides guidance on evaluating a region to identify a site that can meet the licensing requirements for near-surface LLW disposal. The site selection process may vary from State to State or compact to compact² depending on a variety of factors, such as the distribution of waste generators, population distribution, or geologic conditions. However, the minimum technical requirements of § 61.50 of 10 CFR Part 61 and the environmental requirements of 10 CFR Part 51 apply irrespective of the site selection process employed.

The four-step site selection process presented in this regulatory guide is summarized in Table 1. The site suitability discussion (Section C.1) is fundamental to this site selection process.

2.1 Step 1

For the first step, the applicant should define the region of interest, such as the compact or State in which the LLW site will be located. The purpose of this first step is to eliminate unfavorable areas and identify candidate areas for further consideration. The applicant should conduct a search of all published and open file documents on generalized land use, transportation, and geophysical information on a regional or State-wide level. Recent high to mid-level aerial photographs should be evaluated for recent land use changes.

Some examples of areas not suitable for LLW disposal include areas that contain steep terrain, surface waters, wetlands, faults or fracture zones, and karst areas. In addition, there should be no major recharge areas at the site. Examples of significant land use factors that should eliminate areas from further consideration

²The Low-Level Radioactive Waste Amendments Act of 1985 provides the opportunity for States to form compacts to establish and operate regional LLW disposal facilities. Compacts are authorized to restrict the use of their disposal facilities to wastes generated within the compact region.

include proximity to population centers or reserved parcels of committed lands such as active military land, Indian reservations, or parks and monuments. However, other large parcels of public land may be suitable depending on community impact and environmental considerations.

An example of a candidate area suitable for further study would be a sparsely populated area that has no apparent geologic limitations, has easy access to an interstate or limited access highway, and is approximately in the center of major LLW generators. Transportation issues that should be evaluated at this preliminary stage include access, distance from waste generators, and impacts to residential developments along potential transportation routes.

2.2 Step 2

The purpose of Step 2 is to evaluate the candidate areas in order to identify potential candidate sites. Much of the local geophysical and land use data can be obtained through Federal, State, and local agencies. Land use plans, zoning ordinances, U.S. Geological Survey (USGS) and State geological survey reports, and open file data are examples of information sources that may prove useful in developing a list of candidate sites. For example, local land use documents should indicate whether or not development is planned or permitted in candidate areas. USGS and State geologic survey maps and reports often contain detailed information on faults, flood plains, seismic events, and bedrock and soil composition. Also, the reviewer may wish to examine mid- to low-level aerial photographs for recent land use changes. (See NUREG/CR-2861, "Image Analysis for Facility Siting: A Comparison of Low- and High-Altitude Image Interpretability for Land Use/Land Cover Mapping";¹ NUREG/CR-3247, "Site Characterization Information Using LANDSAT Satellite and Other Remote Sensing Data: Integration of Remote Sensing Data with Geographic Information Systems";¹ and NUREG/CR-3583, "Evaluation of Low-Altitude Remote Sensing Techniques for Obtaining Site Characteristic Information,"¹ for more information concerning remote sensing applications for site selection.)

2.3 Step 3

The purpose of this step is to evaluate the candidate sites in order to identify the proposed site. Since the National Environmental Policy Act of 1969 (NEPA) requires an analysis of alternatives to the proposed action (site), an environmental report that contains an evaluation of the candidate sites must be developed at the site characterization stage. Although a complete environmental report is not required until a license application is submitted (§ 61.10), the NRC staff suggests that the applicant consider each category in Chapter 3 of Regulatory Guide 4.18 during the site screening process. An early awareness of the environmental requirements should provide reasonable assurance that a complete environmental report can be submitted with a license application.

TABLE 1
SITE SELECTION PROCESS

	MOST GENERAL			MOST DETAILED
	Step 1	Step 2	Step 3	Step 4*
Category	Region of Interest	Candidate Areas	Candidate Sites	Proposed Sites
Study Area	Compact, State, or geographic region.	A homogeneous area. Sites within an area will contain same general environmental characteristics.	Sites that are potentially licensable.	The site for which the applicant is seeking a license.
Criteria To Be Reviewed	General exclusionary data pertaining to health and safety, areas protected by law.	General compact or State criteria, general screening requirements from § 61.50, and Regulatory Guide 4.18.	General review of compact or State criteria, § 61.50, and information in Regulatory Guide 4.18.	Evaluate compact or State criteria, § 61.50, Regulatory Guide 4.18.
Data To Be Reviewed	USGS and State geologic maps, Federal and State regulations, aerial photographs.	USGS and State geologic maps, topographic maps, university research, land use plans and ordinances, and aerial photographs.	USGS and State geologic maps, topographic maps, university research, local government plans and ordinances and surveys, and local utility maps. Actual field observation.	Evaluate site-specific data.
Level of Analysis	Reconnaissance-level map reviews, literature and regulation reviews.	Reconnaissance review of local maps, high-level aerial photographs, literature, and regulations.	Reconnaissance information and site visits (surface-water samples, low-level aerial photos, onsite photos, air analysis, windshield surveys, etc.).	Demonstrate fulfillment of site characterization requirements. Prepare environmental report as necessary.
Purpose	Identify candidate areas.	Identify candidate sites.	Identify proposed site for characterization.	Meet site licensing requirements.

*Step 4 involves site characterization.

Data collection during this phase of site selection will require reconnaissance reviews and site visits. Soil and surface-water sampling may be conducted. Land use, transportation, and geophysical data described in the previous steps should be reevaluated. Recent low-level aerial photographs may be useful for further evaluation. These photographs may show land use and transportation changes and geophysical features (faults, mass wasting, wetlands) that may not be identified on existing maps. The physical inspection may include a low-level aerial or ground survey (windshield survey) of the site and the surrounding areas. A suggested technique for conducting a site selection analysis after the data are collected is provided in Appendix A.

A substantial amount of information can be obtained through meetings with local utility officials to determine the location of community water distribution systems and other utilities. This information may be important in candidate areas where the presence of potable wells may require the installation of a new water distribution system or an extension from an existing system to ensure the availability of adequate potable water. In addition, information on the location of existing and planned electrical distribution systems is also important in planning for adequate cost-effective power at the candidate disposal facility.

At this stage of screening, a title search of the candidate sites should be conducted. Land ownership information is important so that proper authorities and land owners may be contacted concerning planned onsite visits and surveys. Knowledge of site parcel ownership is important because publicly held land may

be easier to acquire for public use. Some states lack the power of eminent domain; therefore privately owned lands may not be available unless the owner is willing to sell. However, dedicated park land should not be used unless it can be demonstrated that there would be no significant environmental or community impacts.

Meteorological factors that structures may be subjected to should be considered, such as maximum ice and wind loads. The frequency of extreme meteorological conditions such as hurricanes, tornadoes, waterspouts, and thunderstorms should be considered, as well as extreme precipitation rates and extreme forms of air pollution. Information on these meteorological conditions may be obtained from the U.S. Department of Commerce (National Oceanic and Atmospheric Administration) and other relevant government agencies.

2.4 Step 4

The purpose of this step is to evaluate the proposed site to determine whether it is licensable. A licensable site would fulfill the technical requirements of § 61.50, help ensure that the performance objectives of Subpart C of 10 CFR Part 61 will be met, and satisfy the requirements of NEPA. A successful screening program will identify a site that can be licensed for near-surface disposal of LLW.

Guidance on implementing Step 4 (site characterization) can be obtained from NUREG-0902, Regulatory Guide 4.18, and NUREG-1199, "Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility."

APPENDIX A

GEOGRAPHIC INFORMATION COMPUTER MAPPING

In order to expedite the site selection process, it may be desirable to conduct a geographic information system (GIS) analysis of relevant geophysical and land-use data. An effective GIS technique is computer mapping where geophysical, land-use, and demographic factors are encoded to form a data base for analysis. Each factor should be plotted on separate maps that were generated from the same base map. Each map should then be encoded. It is important that the base map (such as USGS 7.5-minute quadrangle maps) have a coordinate grid system (latitude-longitude or UTM grid) so that the encoded data may be referenced and placed into the data base format for computer mapping analysis.

Once the relevant data are encoded and geophysically referenced according to a set of coordinates, site optimization analysis may begin. The primary feature of a computer mapping program is its capability to composite several factor maps to produce a single derivative map. The compositing is done on a cell-by-cell basis summing the factors within each cell. The user assigns a numeric value or "weight" to each of the mapped factors, and each cell accumulates a "score." The score is the result of the sum of the weights in each cell. A user-supplied symbol is applied to each score level, and the composite map is produced on a line printer.

A simplified example of the compositing analysis process is shown in Figure 1. In this example, the system user wants to locate a LLW disposal site in an area free of three factors: shallow bedrock, surface water, and mature trees (1-A).

The relative importance of each factor is represented by a weight that is assigned by the user. In this case, trees have been assigned the greatest importance and shallow bedrock the least (1-C). The seven unique combinations of these factors produce scores from one through seven; each score represents only one combination (1-D). For example, a score of three can only result from the combination of shallow bedrock and streams. The user could assign the greatest importance to bedrock to determine how areas of relative site suitability would change based on altering the importance of each factor.

The result of the analysis is a computer-generated composite map that indicates areas most suited for siting LLW disposal facilities based on given weighted factors (1-E). In this case, the user has represented least desirable areas by dark symbols and most desirable areas as white or unpatterned (1-E).

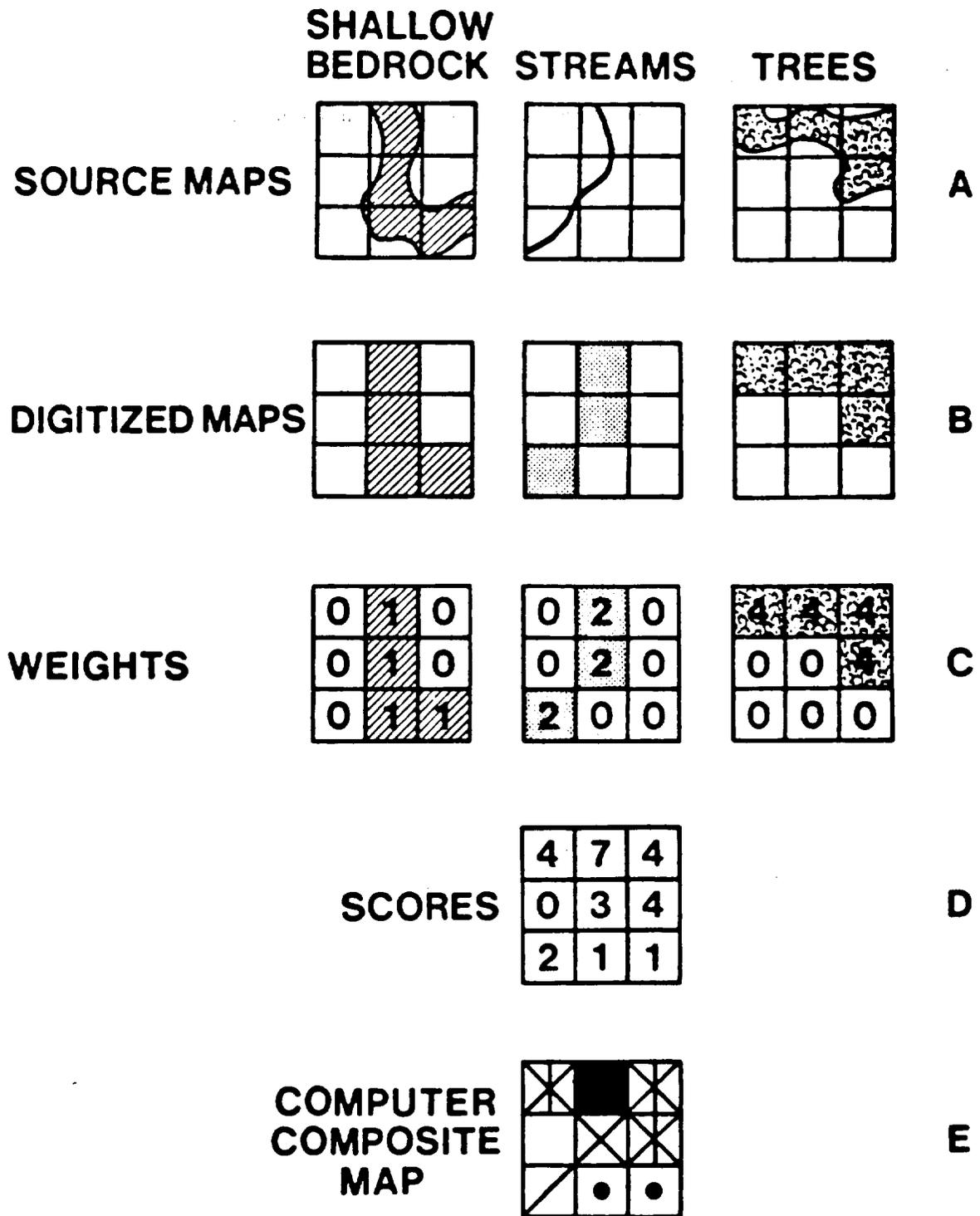


Figure 1. EXAMPLE OF COMPOSITING ANALYSIS

VALUE/IMPACT STATEMENT

A draft value/impact statement was published with the draft regulatory guide (Task WM 408-4) when the draft guide was published for public comment in March 1987. No changes were necessary, so a separate value/impact statement for the final guide has not been prepared. A copy of the draft value/impact statement is available for inspection and copying for a fee at the Commission's Public Document Room at 1717 H Street NW., Washington, DC, under Task WM 408-4.

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