2.0 SITE CHARACTERIZATION

2.1 Site Location and Layout

2.1.1 Areas of Review

The staff should review geographic maps, topographic maps, and drawings that identify the site and its location relative to federal, state, county, and other political subdivisions. These should include maps provided to show the location and layout of the proposed facilities, well fields, and all principal structures such as surface impoundments, deep injection wells, recovery plant buildings, exclusion area boundaries and fences, applicant property and leases, and adjacent properties.

The regional location and site layout for the proposed *in situ* leach operations should be reviewed using maps that show the relationship of the site to local water bodies (lakes, streams); geographic features (highlands, forests); geologic features (faults, folds, outcrops); transportation links (roads, rails, airports, waterways); political subdivisions (counties, townships); population centers (cities, towns); historical and archeological features; key species habitat; and non-applicant property (farms, settlements). A contour map of the site showing a plan layout of constructions, significant topographic variations of the site environs, and drainage gradients, should be evaluated.

2.1.2 Review Procedures

The reviewer should establish the validity and completeness of the basic data, to determine that the site location and layout proposed in the application are complete and accurate, and that the site information is sufficient to evaluate the location of the proposed facilities relative to key features and activities. For new applications, the staff should conduct a site visit of the facility, after becoming familiar with the submitted materials, to develop an acceptable familiarization for the review and to verify the general aspects of the submitted materials.

The staff should examine maps and drawings provided in the application and associated environmental reports to determine whether they provide sufficient detail to locate the site regionally relative to local political subdivisions and natural and man-made features and that the maps allow the staff to determine the proposed layout within the existing topography at the site. On a regional scale, the reviewer should examine the location of the facility and all federal, state, county, and local political subdivisions that have a bearing on estimating the environmental impact of the proposed operations. The staff should verify that the total acreage that is owned or leased by the applicant and the portion of that real estate or any adjacent properties that could be affected by site activities have been identified. The reviewer should examine a contour map to determine that the contour intervals and information included on the map are sufficient to show any significant variations in site environs and important drainage gradients. The staff should also determine that the relationship between the site and surface drainage is readily apparent from the provided maps. Likewise, it should be possible to ascertain the likely areas of and effects of site activities on local flora and fauna from the location maps. The staff should determine that the scale and clarity of the maps are adequate to conduct the necessary environmental and safety reviews.

Site Characterization

Reviewers should keep in mind that the development and initial licensing of an *in situ* leach facility is not based on comprehensive information. This is because *in situ* leach facilities obtain enough information to generally locate the ore body and understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should ensure that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of all the operations will be available in the initial application.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.1.3 Acceptance Criteria

The characterization of the site location and layout is acceptable if it meets the following criteria:

(1) Maps are provided that show geologic features, well fields, and all planned principal structures such as surface impoundments, diversion channels, monitoring wells, deep injection wells, and recovery plant buildings. If detailed information on actual well field design is not available at the time of the initial facility application, the maps show the expected well field locations with an indication that this information is preliminary.

(2) Any maps previously submitted (e.g., maps from the original application in the case of renewals) are legible, and actual or proposed changes are highlighted.

(3) Maps are provided that show exclusion area boundaries and fences.

(4) Maps are provided that show the applicant property and leases and current adjacent properties, including water bodies, forests, and farms, and all federal, state, county, and local political subdivisions.

(5) Maps are provided that show nearby population centers and transportation links such as railroads, highways, and waterways.

(6) A topographic map is provided with elevation contours that show the locations of drainage basins and variations in the drainage gradient in the vicinity of the proposed *in situ* leach facility. The specific locations of natural streams and proposed diversion channels, relative to principal structures, should also be provided.

(7) The proposed *in situ* leach facility is clearly labeled at a scale appropriate to the area being covered (regional and local) and with sufficient clarity and detail to allow identification and evaluation of the proposed *in situ* leach facility. Maps are at an appropriate scale and are clear and readable.

(8) Data sources are documented in reports such as U.S. Geological Survey open files or existing published maps. If data have been generated by the applicant, the data documentation should include a description of the investigation and data reduction techniques.

(9) Maps include designation of scale, orientation (e.g., north arrow), and geographic coordinates. In addition to maps, the applicant may provide tabular locations of facilities using universal transverse Mercator coordinates with appropriate Northing and cross-section in meters.

2.1.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the description of the site location and layout, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with site location and layout at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.1.2 and the acceptance criteria outlined in standard review plan Section 2.1.3.

The licensee has acceptably described the site location and layout with appropriately scaled and labeled maps showing site layout, principal facilities and structures, regional location, geology, boundaries, exclusion areas and fences, applicant property including leases and adjacent properties, nearby population centers and transportation links, and topography. References are cited acceptably. Any maps previously submitted (e.g., maps from the original application in the case of renewals) are legible, and actual or proposed changes are highlighted.

Based on the information provided in the application, and the detailed review conducted of the characterization of site location and layout for the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.1.5 References

None.

2.2 Uses of Adjacent Lands and Waters

2.2.1 Areas of Review

The staff should review descriptions of the nature and extent of present and projected land use (e.g., agriculture, sanctuaries, hunting, mining, grazing, industry, recreation, roads), any recent

trends or changes in population or industrial patterns, and any other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site.

The staff should also review tables showing, for each of the 22½-degree sectors centered on each of the 16 compass points (i.e., north, north-northeast, etc.), the distances {to a distance of 3.3 km [2 mi]} from the center of the site to the nearest resident and to the nearest site boundary.

The staff review should include the location, nature, and amounts of present and projected surface-water and ground-water use (e.g., water supplies, irrigation, reservoirs, recreation, and transportation) within 3.3 km [2 mi] of the site boundary {0.8 km [0.5 mi] for research and development operations} and the present and projected population associated with each use point.

2.2.2 Review Procedures

The reviewer should determine whether the application provides sufficient information on the use of the lands and waters within a 3.3 km [2 mi] distance from the site boundary surrounding the proposed facilities {0.8 km [0.5 mi] for research and development operations} to assess the likely consequences of any impacts of *in situ* leach operations on adjacent properties.

The staff should determine that the application contains the location of residences, ground-water supply wells, surface-water reservoirs, and the estimated use of water in the lands surrounding the site of the proposed facility. Data sources should be referenced. This information should be evaluated to determine whether it is sufficient to delineate the likely impact(s) of the facility, under both normal operating conditions and accidents, on the ground water, surface-water, and population (both human and animal) near the site. The reviewer should determine that within 3.3 km [2 mi] from the site boundary, the nature and extent of present and projected water and land use and any other trends or changes in population or industrial patterns have been reported. Any other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site should be identified.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining historical aspects of facility performance and the approach that should be used in evaluating amendments and renewal applications.

2.2.3 Acceptance Criteria

The characterization of the uses of adjacent lands and waters is acceptable if it meets the following criteria:

(1) Information is presented in detail sufficient to understand the surrounding land and water uses, such that the likely consequences imposed by *in situ* leach operations can be adequately assessed.

Although the specific requirements may vary from site to site, the general purpose for determining land and water use patterns is to provide supporting data for exposure calculations, cost-benefit analyses, and determinations of air emissions (e.g., dust). A 3.3-km [2-mi] distance from the site boundary is an acceptable area for which land and water use data should be collected. One acceptable method for presenting these data is for the applicant to provide the information requested in the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982), Section 2.2. The information presented should include:

(a) Maps showing the locations of nearest residences, ground-water supply wells, and abandoned wells

(b) Types of present and projected (life of facility) water use (e.g., municipal, domestic, agriculture, livestock) and descriptions of the methodology and sources used to develop projections

(c) Present and projected (life of facility) water use estimates, by type, for both ground-water and surface-water, including present and projected withdrawal, and descriptions of the methodology and sources used to develop projections

(d) For existing ground-water wells, well depth, ground-water elevations, flow rates, drawdown, and a description of the producing aquifer(s)

(e) The locations of abandoned wells and drill holes, including the depth, type of use, condition of closing, plugging procedure used, and date of completion for each well or drill hole within the site area and within 0.4 km [.25 mi] of the well field boundary

(f) Descriptions of the nature and extent of projected land use (e.g., agriculture, recreation, industry, grazing, and infrastructure) and descriptions of the methodology and sources used to develop projections

(g) The location of any other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site

(2) For each of the 22½-degree sectors centered on the 16 cardinal compass points, the information identified in Section 2.2.3 of the Standard Format and Content of License Application, Including Environment Report (NRC, 1982) concerning human residences, nearest site boundary(ies) to residences, surface- and ground-water use, and projected water use, is provided. As described in Section 2.2 of the Standard Format and Content of License Application, Including Environment Report (NRC, 1982), appropriate presentation of the data should include mapped data as appropriate, a tabular summary for each of the 22½-degree sectors centered on the 16 cardinal compass points, and for each, the distance from the center of the site to the site boundary and the nearest residence.

(3) Data sources are documented in reports such as U.S. Geological Survey open files or existing published reports or maps. If data have been generated by the applicant, the data documentation should include a description of the investigations and data reduction techniques.

(4) Maps include designation of scale, orientation (e.g., north arrow), and geographic coordinates.

2.2.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the described uses of adjacent lands and waters, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with uses of adjacent lands and waters near the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.2.2 and acceptance criteria outlined in standard review plan Section 2.2.3.

The applicant has acceptably described the present and projected land use, including residential, commercial, agricultural, industrial, flora and fauna sanctuaries, arboreal, grazing, recreation (e.g., hunting, swimming, skiing), and infrastructure. Appropriate information on the location and extent of each use has been provided. In particular, the description and associated tabulated data of the location, nature, amounts, and population associated with each use point of present and projected (life of the facility) surface and ground-water adjacent to the site including water supplies, irrigation, reservoirs, recreation, and transportation within at least 3.3 km [2 mi] of the site boundary {0.8 km [0.5 mi] for research and development operations} are acceptable for determination of likely impacts of the proposed *in situ* leach facility. Tabulated data on present and projected water withdrawal rates, return rates, types of water use (e.g., municipal, domestic, agriculture, and livestock); source, water-use estimates, and abandoned well locations are acceptable. The applicant has identified and located (or has noted the absence of) other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site.

Based on the information provided in the application, and the detailed review conducted of the characterization of uses of adjacent lands and waters for the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45 which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis, and 10 CFR Part 40, Appendix A, Criteria 5B(4) and 5G(3) which provide criteria for identification if underground sources of drinking water and exempted aquifers and the current uses of ground water.

2.2.5 Reference

NRC. Regulatory Guide 3.46, “Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining.” Washington, DC: NRC, Office of Standards Development. 1982.

2.3 Population Distribution

2.3.1 Areas of Review

The staff should review population data based on the most recent census, including maps that identify places of significant population grouping, such as cities and towns within an 80-km [50-mi] radius {3.2 km [2 mi] for research and development operations} from the approximate center of projected (life of facility) activities in the format specified in the Standard Format and Content of License Application, Including Environmental Reports (NRC, 1982). For the purposes of environmental justice (see Sections 7.6.1.3) and NUREG–1748 (NRC, 2001) the staff should also examine the distribution of low-income and minority populations based on the most recent census data available. The staff should review the basis for population projections.

In addition, for commercial-scale operations, the staff should review descriptive material giving significant population and visitor statistics of neighboring schools, plants, hospitals, sports facilities, residential areas, parks, *et cetera*, within 3.3 km [2 mi] of the *in situ* leach operations. The review should include appropriate available food production data in kg/yr for vegetables (by type and totals), meat (all types), and milk, and any available future predictions for this production by local governmental, industrial, or institutional organizations within 3.3 km [2 mi] of the site boundary.

2.3.2 Review Procedures

The reviewer should determine that data have been tabulated and presented in pie segments as described in Section 2.3 of the Standard Format and Content of License Application, Including Environmental Reports (NRC, 1982). The basis for population projections should be examined. Recent agricultural production data should be tabulated for vegetables, meat, milk, and other foodstuffs, in addition to predictions for future production by government, industry, or institutions for land within 3.3 km [2 mi] of the site. It is important to ascertain that the most recent census data have been used and that the data presented will support subsequent exposure and dose calculations and risk assessments.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.3.3 Acceptance Criteria

The characterization of the population distribution is acceptable if it meets the following criteria:

(1) Population data, including demographic information on minority and low-income populations, are provided based on generally accepted sources such as the U.S. Census Bureau, and other federal, state, and local agencies.

(2) A map of suitable scale is provided that identifies significant population centers within an 80-km radius [50 mi] {3.2 km [2 mi] for research and development operations} from the approximate center of the projected activities.

(3) A map of suitable scale is provided, centered on the proposed ISL facility, marked with concentric circles at 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70, and 80 km divided into 22½-degree sectors centered on one of the 16 compass points. A table keyed to this map showing separate and cumulative population totals for each sector and annular ring is provided. The distance to the nearest residence is noted for each sector.

(4) Descriptions of significant population and visitor statistics of neighboring schools, plants, hospitals, sports facilities, residential areas, parks, and forests within 3.2 km [2 mi] of the proposed *in situ* leach facility, based on generally accepted sources such as the U.S. Census Bureau, and state and local agencies, are provided, with identification of data sources.

(5) Projections are included of population, visitor, and food production data over the expected life of the *in situ* leach facility (typically tens of years).

(6) Descriptions of the methodology and sources used to develop projections are provided.

The food production data are acceptable if data (kg/yr) for vegetables, meat, and milk, based on generally accepted sources such as the U.S. Department of Agriculture, Farm Bureau, and state and local agriculture services, are provided, with identification of data sources.

2.3.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the population distribution and food production data, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with population distribution and food production near the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.3.2 and acceptance criteria outlined in standard review plan Section 2.3.3.

The applicant has acceptably described the population distribution using population data from generally accepted sources. A map showing the location of significant population centers,

within an 80-km radius [50 mi] of the approximate center of proposed operations, is provided. A table and accompanying map providing population in pie-shaped wedges, centered on each of the 16 compass points, is included. Nearest residence distances are noted for each sector. The applicant has provided acceptable information on minority and low-income populations, schools, industrial facilities, sports facilities, residential areas, parks, and forests within 3.2 km [2 mi] of the proposed *in situ* leach facility. Food production data (e.g., vegetables, meat, milk) have been described and keyed on a map. Based on a description of the methodology and sources, all the data have been appropriately projected for the proposed life of the *in situ* leach facility.

Based on the information provided in the application, and the detailed review conducted of the characterization of population distribution and food production for the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.3.5 References

NRC. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

———. NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs." Washington, DC: NRC. 2001.

2.4 Historic, Scenic, and Cultural Resources

2.4.1 Areas of Review

The staff shall review discussions of the historic, cultural, and scenic resources, if any, within the area of potential effect. Historic properties include districts, sites, buildings, structures, or objects of historical, archaeological, architectural, or traditional cultural significance. Specific attention should be directed to properties included in or eligible for inclusion in the National Register of Historic Places (the National Register) and properties registered as National Natural Landmarks.

The staff should review identifications of those properties included in, or eligible for, inclusion in the National Register of Historic Places, located within the area of the proposed project, and should review evidence of contact with the appropriate state historic preservation officer, including a copy of any state historic preservation officer comments concerning the effect of the facility on historic, scenic, and cultural resources.

The review should include information on whether new roads, pipelines, or utilities for the proposed activity will pass through or near any area or location of known historic, scenic, or cultural significance.

2.4.2 Review Procedures

The staff should determine that the applicant has used the appropriate databases and records to identify historic, scenic, and cultural resources that are found within the study region. The staff should determine that the locations and descriptions of the features are sufficient to allow an evaluation of the likely impacts of the proposed facilities on these resources. Of particular interest are features included in, or eligible for inclusion in, the National Register and National Natural Landmarks. Means to consider and treat such data are discussed in several National Park Service guidelines (e.g., National Park Service, 1973, 1990, 1995). The reviewer should verify that data presented support estimates of long-term costs in terms of the likely impacts on the aesthetic or recreational values of such landmarks. It is important that the application document evidence of contact with knowledgeable sources when no historic, scenic, or cultural resources are identified by the applicant within the study area. The reviewer should examine the likely impact of new roads, pipelines, or other utilities on areas and locations of known historic, scenic, or cultural significance [White House, 2000 (Executive Order 13175)].

The reviewer should also confer with the state historic preservation officer as required by 36 CFR Part 800. As specified in Part 800, the state historic preservation officer can enter into a memorandum of understanding to assume the function of the Advisory Council on Historic Preservation. In these situations, consistent with 36 CFR 800.7(b)(1), NRC can comply with the state review process in lieu of the Advisory Council on Historic Preservation regulations. If such a memorandum of understanding is not in place, the staff must consult with the state historic preservation officer and other interested parties. If adverse effects are found, and the Advisory Council on Historic Preservation does not participate, the NRC may enter into a memorandum of agreement with the State Historic Preservation Officer as specified in 36 CFR 800.6(b)(1). The NRC must submit a copy of the executed memorandum of agreement, along with the documentation specified in 36 CFR 800.11(f) to the Advisory Council on Historic Preservation prior to approving the undertaking in order to meet the requirements of Section 106 of the National Historic Preservation Act. If adverse effects are found, and the Advisory Council on Historic Preservation does not participate, the NRC should follow the requirements of 36 CFR 800.6(b)(2).

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.4.3 Acceptance Criteria

The characterization of regional historic, scenic, and cultural resources is acceptable if it meets the following criteria:

(1) A listing for all properties included in, or eligible for inclusion in, the National Register including National Natural Landmarks is provided.

(2) A map is included showing all identified National Register Properties and National Natural Landmarks with respect to the location of facilities such as buildings, new roads, well fields, pipelines, surface impoundments, and utilities that might affect these areas.

A license condition will be placed in the license prohibiting work if any previously unknown cultural artifacts are found.

(3) Discussions are incorporated of the treatment of areas of historic, scenic, and cultural significance that follow guidance equivalent to that provided by the National Park Service Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archeological, Architectural) Resources (National Park Service, 1973). Where appropriate, tribal authorities have been consulted on the likely impacts on Native American cultural resources (White House, 2000). For a consideration of environmental justice, see Section 7.6.1.3, Acceptance Criterion (3) and NUREG–1748 (NRC, 2001).

(4) If delegated by NRC, the applicant provides evidence of contact with the appropriate state historic preservation officer and tribal authorities. This evidence includes a copy of comments of the state historic preservation officer and tribal authority concerning the effects of the proposed facility on historic, archeological, architectural, and cultural resources.

(5) If delegated by NRC, the applicant presents a memorandum of agreement among the state historic preservation officer, tribal authorities, and other interested parties regarding their satisfaction with regard to the protection of historic, archeological, architectural, and cultural resources during site construction and operations.

(6) A letter from the state historic preservation officer has been obtained that discusses any issues associated with sites in, or eligible for inclusion in, the National Register, National Natural Landmarks, or other cultural properties that may be affected by the *in situ* leach operations.

(7) The aesthetic and scenic quality of the site is rated in accordance with U.S. Bureau of Land Management 8400—Visual Resource Management (U.S. Bureau of Land Management, 2001).

If the rating is below 19 (scale of 0 to 33), no special management is required. If the rating is 19 or above, the application provides a management plan for minimizing the impact of the proposed facility.

2.4.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the characterization of the historic, scenic, and cultural resources the following conclusions may be presented in the environmental assessment.

Site Characterization

NRC has completed its review of the site characterization information concerned with regional historic, scenic, and cultural resources near the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.4.2 and acceptance criteria outlined in standard review plan Section 2.4.3.

The licensee has acceptably described the historic, scenic, and cultural resources. A listing of all nearby areas and properties included or eligible for inclusion in the National Register or National Natural Landmarks is provided. A map showing all historic landmarks and places with respect to *in situ* leach facilities is included. A record of the investigation of places and properties with historic, scenic, and cultural significance, which follows guidance equivalent to that of the National Park Service, is provided. Contact with local tribal authorities, where appropriate, is acceptably documented. A letter from the state historic preservation officer addressing any issues related to the properties that might be affected by the *in situ* leach facilities is included. The applicant has acceptably demonstrated that the state historic preservation officer and tribal authorities agree with the planned protection from or determination of lack of conflict with *in situ* leach facilities and activities and with any places of importance to the state, federal, or tribal authorities. The applicant has acceptably rated the aesthetic and scenic quality of the site in accordance with the U.S. Bureau of Land Management Visual Resource Inventory and Evaluation System.

Based on the information provided in the application, and the detailed review conducted of the characterization of regional historic, archeological, architectural, scenic, cultural, and natural landmarks near the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.4.5 References

National Park Service. "How to Apply the National Register Criteria for Evaluation." National Park Service Bulletin No. 15. Washington, DC: National Park Service, U.S. Department of the Interior. 1995.

———. "Guidelines for Evaluating and Documenting Traditional Cultural Properties. National Register Bulletin No. 38. Washington, DC: National Park Service, U.S. Department of the Interior. 1990.

———. "Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archeological, Architectural) Resources." Washington, DC: National Park Service. 1973.

NRC. NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs." Washington, DC: NRC. 2001.

U.S. Bureau of Land Management. "Visual Resource Management." U.S. Bureau of Land Management Manual—8400. Washington, DC: U.S. Department of the Interior. http://lm0005.blm.gov/nstc/rrm/8400.html. 2000.

White House. "Consultation and Coordination with Indian Tribal Governments." Executive Order 13175. *Federal Register.* Vol. 65. pp. 67249–67252. 2000.

2.5 Meteorology

2.5.1 Areas of Review

The staff should review descriptions of the atmospheric diffusion characteristics of the site and its surrounding area based on data collected onsite or at nearby meteorological stations. The data to be reviewed include

(1) National Weather Service station data, including locations of all National Weather Service stations within an 80-km [50-mi] radius; and available joint frequency distribution data by wind direction, wind speed, stability class, period of record, and height of data measurement

(2) On-site meteorological data, including locations and heights of instrumentation, descriptions of instrumentation, and joint frequency distribution data, if National Weather Service data representative of the site are not available

(3) Miscellaneous data, including annual average mixing layer heights, a description of the regional climatology, and total precipitation and evaporation, by month

The staff should also review a discussion of the general climatology including existing air quality, the relationship of the regional meteorological data to the local data, the meteorological impact of the local terrain and large lakes and other bodies of water, and the occurrence of severe weather in the area and its effects. This review should also include data on averages of temperature and humidity.

2.5.2 Review Procedures

The staff should determine whether the application includes sufficient local and regional-scale meteorological information to support estimates of airborne radionuclide transport from the proposed *in situ* leach facility to the surrounding area and for determination of airborne pathway inputs to risk assessment models. This information may include National Weather Service data, on-site monitoring data, or data from local meteorological stations, and any maps or tables that describe meteorological conditions at the site and surrounding area. Section 2.5 of the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982) contains a list of acceptable meteorological data requirements.

Site Characterization

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.5.3 Acceptance Criteria

The characterization of the site meteorology is acceptable if it meets the following criteria:

(1) A description of the general climate of the region and local meteorological conditions is provided, based on appropriate data from National Weather Service, military, or other stations recognized as standard installations.

These data include precipitation, evaporation, and joint-frequency distribution data by wind direction, wind speed, stability class, period of record, and height of data measurement. The average inversion height should also be identified. Data should also be provided on diurnal and monthly averages of temperature and humidity. The locations of all stations used in the data analysis and the height of the data measurement should be included. Data periods should be defined by month and year and cover a sufficient time period to constrain long-term trends and support atmospheric dispersion modeling.

Data from local meteorological weather stations supplemented, if necessary, by data from an on-site monitoring program, are provided.

A minimum of one full year of joint frequency data presented with a joint data recovery of 90 percent or more is provided.

The on-site program should be designed in accordance with Regulatory Guide 3.63, “Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting” (NRC, 1988).

(2) Consideration of relationships between regional weather patterns and local meteorological conditions based on weather station data and the on-site monitoring program, if necessary, is included. The impacts of terrain and nearby bodies of water on local meteorology are assessed, and the occurrence of locally severe weather is described and its impact considered.

Information on anticipated air quality impacts from non-radiological sources, such as vehicle emissions and dust from well field activities, is provided for assessing cumulative impacts.

(3) The meteorological data used for assessing impacts are substantiated as being representative of expected long-term conditions at and near the site.

(4) The application contains a description of existing air quality.

The applicant must demonstrate that the radiological and non-radiological air quality impacts caused by *in situ* leach facilities are virtually indistinguishable from background, or information on the likelihood of air pollution is based on U.S. Environmental Protection Agency (EPA) studies. Affected counties within 80 km [50 mi] of the facility are classified according to the National Ambient Air Quality Standards as being in attainment (below National Ambient Air Quality Standards) or nonattainment (above National Ambient Air Quality Standards status.

(5) The sources of all meteorological and air quality data are documented in open file reports or other published documents. If data have been generated by the applicant the data documentation should include a description of the investigations and data reduction techniques.

2.5.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the meteorology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with meteorology at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.5.2 and acceptance criteria outlined in standard review plan Section 2.5.3.

The licensee has acceptably described the site meteorology by providing data from National Weather Service military, or other stations recognized as standard installations located within 80 km [50 mi] of the site, including available joint frequency distribution data on (i) wind direction and speed, (ii) stability class, (iii) period of record, (iv) height of data measurement, and (v) average inversion height. The data cover a sufficient time period to constrain long-term trends and support atmospheric dispersion modeling. The applicant has provided acceptable on-site meteorological data, if necessary, including (i) descriptions of instruments, (ii) locations and heights of instruments, and (iii) joint frequency distributions. The joint-frequency data presented are for a minimum of 1 year, with a joint data recovery of 90 percent or more. Additional data on (i) annual average mixing layer heights, (ii) a description of the regional climate, and (iii) total precipitation and evaporation by month have been provided. The applicant has noted any effect of nearby water bodies or terrain on meteorologic measurements. The applicant has acceptably demonstrated that meteorologic data used for assessing environmental impacts are representative of long-term meteorologic conditions at the site. The applicant report on the existing air quality at the site and nearby is acceptable.

Based on the information provided in the application, and the detailed review conducted of the characterization of meteorology at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the spread of airborne contamination at the site and development of conceptual and numerical models, and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis. The

characterization also meets the requirements of 10 CFR Part 40, Appendix A, Criterion 7, which requires pre-operational and operational monitoring programs.

2.5.5 References

NRC. Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting." Washington, DC: NRC, Office of Standards Development. 1988.

———. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

2.6 Geology and Seismology

2.6.1 Areas of Review

The reviewer should examine information on the geologic aspects of the site acquired through standard geologic analyses, including a survey of pertinent literature and field investigations. This information should include regional seismicity and seismic history, local stratigraphy, petrology or lithology of rock units, tectonic features (faulting, folding, fracturing), and the continuity of the geologic strata at the site and in nearby regions.

Geologic, structural, and stratigraphic maps and cross sections, including representative core and geophysical well-log data of the site and its environs, should be reviewed. An isopach map of the intended zone of injection or production and associated confining beds should be evaluated. All conclusions regarding the lateral continuity and vertical thickness of the mineralized zone(s), surrounding lithologic units, and confining zones, as based on lithologic logs from core and drill cuttings, geophysical data, remote-sensing measurements, and the results of other appropriate investigations should be reviewed. Some of the applicant's supporting information for this review area might be included in the documents submitted to satisfy the hydrology review area (Section 2.7).

The staff should review the information presented on any economically important minerals and energy-related deposits in addition to the uranium mineralization, including the likely consequences of any production of such related deposits on the *in situ* leach facility.

Data on the geochemistry of the ore zone and the geologic zones immediately surrounding the mineralized zone that will or could be affected by injected lixiviant should be evaluated. Information on unique minerals (including those that might be affected by fluid movement associated with the proposed project, such as bentonite) or paleontologic deposits of particular scientific interest, should also be reviewed. The staff should examine descriptions of any effects that planned operations at the site might have on the future availability of other mineral resources.

2.6.2 Review Procedures

The staff should review the application to determine whether a thorough evaluation of the geologic setting for the proposed *in situ* leach activity has been presented along with the basic data supporting all conclusions. In addition to a description of the basic geology, both at the surface and at the depths of interest, the establishment of the continuity of the geologic strata at the site should be reviewed for applicability, correctness, inclusivity, and likely ability of the strata to isolate *in situ* leach fluids. The reviewer should particularly focus attention on fractures or faults, permeable stratigraphic units, and lateral facies changes that might preclude the applicant-identified geologic barriers to fluid migration from performing adequately.

The reviewer should determine that the application contains accurate geologic maps, isopach maps of the mineralized strata and of the confining layers, geologic cross sections at places critical to a thorough understanding of the selected site, descriptions of representative supporting core samples, geophysical and lithologic logs, and other data required for a thorough understanding of the pertinent geology. The reviewer should determine that regional stratigraphic and geologic information is discussed in sufficient detail to give clear perspective and orientation to the site-specific material presented. The discussion of regional geology and stratigraphy should be assessed to determine if it is adequately referenced and is illustrated by regional surface and subsurface geologic maps, stratigraphic columns, and cross sections. Seismic information should be evaluated to assess its suitability for evaluating seismic hazard for the proposed facility.

The staff may also perform an independent analysis of the data provided to assess whether reasonable and conservative alternative interpretations are indicated.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.6.3 Acceptance Criteria

The characterizations of the site geology and seismology are acceptable if they meet the following criteria:

(1) The application includes a description of the local and regional stratigraphy based on techniques such as

(a) Surface sampling and descriptions

(b) Cuttings and core logging reports

(c) Wireline geophysical logs, such as electrical resistivity, neutron density, and gamma logs

(d) Geologic interpretations of surface geology and balanced cross sections

These interpretations may be based either on original work submitted by the applicant, or on an appropriate evaluation of previous work in the region performed by state or federal agencies (e.g., U.S. Geological Survey, U.S. Bureau of Land Reclamation, U.S. Bureau of Mines), universities, mining companies, or oil and gas exploration companies. The interpretations should be accompanied by

(i) Maps such as geologic, topographic, and isopach maps that show surface and subsurface geology and locations for all wells used in defining the stratigraphy

(ii) Cross-sections through the ore deposit roughly perpendicular and parallel to the principal ore trend

(iii) Fence diagrams showing stratigraphic correlations among wells

(2) All maps and cross-sections are at sufficient scale and resolution to show clearly the intended geologic information. Maps show the locations of all site explorations such as borings, trenches, seismic lines, piezometer readings, and geologic cross sections.

(3) In the local stratigraphic section, all mineralized horizons, confining units, and other important units such as drinking water aquifers and deep well injection zones are clearly shown, with their depths from the surface clearly indicated. Isopach maps are prepared showing the variations in thickness of the mineralized zones and the confining units over the proposed mining area.

(4) A geologic and geochemical description of the mineralized zone and the geologic units immediately surrounding the mineralized zone is provided.

(5) An inventory of economically significant mineral and energy-related deposits, in addition to the uranium mineralization, is provided. Locations of all known wells, surface and underground mine workings, and surface impoundments that may have an effect on the proposed operations are provided.

These items should be located on a map of sufficient scale and clarity to identify their relationship to the proposed facility. For existing wells, the depth should be shown, if possible. To allow evaluation of connections between the mineralized zone and underground sources of drinking water, plugging and abandonment records provided from state, federal, and local sources, as appropriate, should be provided. The applicant should provide evidence that action has been undertaken to properly plug and abandon all wells that cannot be documented in this manner.

(6) A description of the local and regional geologic structure, including folds and faults, is provided.

Folds and faults can be shown on the geologic maps used to describe the stratigraphy. Major and minor faults traversing the proposed site should be evaluated for the likely

consequences of any future effects of faulting on the uranium production activities and on the ability of the strata to contain lixiviant should fault motion occur. Geologic structures that are preferential pathways or barriers to fluid flow must be described and the basis for likely effects on flow given.

(7) A discussion of the seismicity and the seismic history of the region is included.

Historical seismicity data should be summarized on a regional earthquake epicenter map, including magnitude, location, and date of all known seismic events. Where possible, seismic events should be associated with the tectonic features described in the geologic structures.

(8) A generalized stratigraphic column, including the thicknesses of rock units, representation of lithologies, and definition of the mineralized horizon, is presented.

(9) The sources of all geological and seismological data are documented in U.S. Geological Survey open files or other published documents. If data have been generated by the applicant, the documentation should include a description of the investigations and data reduction techniques.

(10) Maps have designation of scale, orientation (e.g., North arrow), and geographic coordinates.

(11) Short-term seismic stability has been demonstrated for the *in situ* leach facility in accordance with Regulatory Guide 3.11, “Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills,” Section 2.6 (NRC, 1977).

(12) A general description of the site soils and their properties has been provided to support an evaluation of the environmental effects of construction and operation on erosion.

(13) A detailed description of soils and their properties has been provided for any areas where land application of water is anticipated to support an assessment of the impacts.

2.6.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the characterization of the geology and seismology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with geology and seismology at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.6.2 and acceptance criteria outlined in standard review plan Section 2.6.3.

The licensee has acceptably described the geology and seismology by providing (i) a description of the local and regional stratigraphy; (ii) geologic, topographic, and isopach maps

at acceptable scales showing surface and subsurface features and locations of all wells and site explorations used in defining stratigraphy; (iii) a geologic and geochemical description of the mineralized zone and the geologic units adjacent to the mineralized zone; (iv) an inventory of nearby economically significant minerals and energy-related deposits; (v) a description of the local and regional geologic structure; (vi) a discussion of the seismicity and seismic history of the region; (vii) a generalized stratigraphic column that includes thickness of rock units, representation of lithologies, and definition of mineralized horizon; and (viii) a description and map of the soils.

Based on the information provided in the application, and the detailed review conducted of the characterization of the geology and seismology at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the geologic and seismologic characteristics of the site, supports associated conceptual and numerical models, and is in compliance with 10 CFR 40.31(f), which requires inclusion of an environmental report in the application, and 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis. The characterization is sufficient to meet the requirements of 10 CFR Part 40, Appendix A, Criteria 4(e), which requires locations away from faults capable of causing impoundment failure and 5G(2), which requires adequate descriptions of the characteristics of the underlying soils and geologic formations.

2.6.5 Reference

NRC. Regulatory Guide 3.11, “Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills.” Washington, DC: NRC, Office of Standards Development. 1977.

2.7 Hydrology

2.7.1 Areas of Review

Characterization of the hydrology at *in situ* leach uranium extraction facilities must be sufficient to establish potential effects of *in situ* leach operations on the adjacent surface-water and ground-water resources and the potential effects of surface-water flooding on the *in situ* leach facility. The areas of review include:

(1) Descriptions of surface-water features in the site area including type, size, pertinent hydrological or morphological characteristics, and proximity to *in situ* leach processing plants, well fields, evaporation ponds, or other facilities that might be negatively affected by surface erosion or flooding.

(2) Assessment of the potential for erosion or flooding that may require special design features or mitigation measures to be implemented.

(3) A description of site hydrogeology, including (i) identification of aquifer and aquitard formations that may affect or be affected by the *in situ* leach operations; (ii) a description of aquifer properties, including material type, formation thickness, effective porosity,

hydraulic conductivity, and hydraulic gradient; (iii) estimated thickness and lateral extent of aquitards, and other information relative to the control and prevention of excursions; and (iv) data to support conclusions concerning the local ground-water flow system, based on well borings, core samples, water-level measurements, pumping tests, laboratory tests, soil surveys, and other methods

(4) Assessment of available ground-water resources and ground-water quality within the proposed permit boundaries and adjacent properties, including quantitative description of the chemical and radiological characteristics of the ground water and potential changes in water quality caused by operations

(5) An assessment of typical seasonal ranges and averages and the historical extremes for levels of surface-water bodies and aquifers

(6) Information on past, current, and anticipated future water use, including descriptions of local ground-water well locations, type of use, amounts used, and screened intervals

In conducting these evaluations, the reviewer shall consider the technical evaluations conducted by a state or another federal agency with authorities overlapping those of the NRC. Ground-water compliance and protection reviews are the primary technical areas impacted by overlapping authorities. The desired outcome is to identify any areas where duplicative NRC reviews may be reduced or eliminated. The NRC staff must make the necessary evaluations of compliance with applicable regulations for licensing the facility. However, the reviewer may, as appropriate, rely on the applicant's responses to inquiries made by a state or another federal agency to support the NRC evaluation of compliance. The reviewer should make every effort to coordinate the NRC technical review with the state or other federal agency with overlapping authority to avoid unnecessary duplication of effort.

2.7.2 Review Procedures

At a minimum, the reviewer should evaluate whether the applicant has developed an acceptable conceptual model of the site hydrology and whether the conceptual model is adequately supported by the data presented in the site characterization. To this end, the reviewer should:

(1) Review surface-water data, including maps that identify nearby lakes, rivers, surface drainage areas, or other surface-water bodies; stream flow data; and the applicant's assessment of the likely consequences of surface-water contamination from *in situ* leach operations. Verify that the applicant has generally characterized perennial surface-water bodies, such that an assessment of impacts from operations can be made.

(2) Evaluate the applicant's assessment of the potential for erosion or flooding. If surface water or erosion modeling is used by the applicant, verify that acceptable models and input parameters have been used in the flood analyses and that the resulting flood forces have been acceptably accommodated in the design of surface impoundments.

Regardless of whether modeling is used, ensure that the evaluation of flooding and erosion potential is consistent with available geomorphological, and topographic data or analysis of paleodischarge information.

(3) Evaluate the site hydrogeologic conceptual model for ground-water flow in potentially affected aquifers. Review available data from well logs and hydrologic tests and measurements to obtain confidence that sufficient data have been collected and that the data support the applicant's hydrologic conceptual model for ground-water flow within and around the permit boundary. The applicant's interpretation of ground-water hydraulic gradients (used to infer flow direction), horizontal hydraulic conductivity, and the thickness, areal extent, and vertical hydraulic conductivity of confining formations should be evaluated. Examine pumping tests, analyses, and/or other measurement techniques used to determine the hydrologic properties of the local aquifers and aquitards that affect or may be affected by the proposed *in situ* leach activities. Also examine pumping tests that are used to investigate vertical confinement or hydraulic isolation between the ore production zone and upper and lower aquifers.

(4) Evaluate the applicant's assessment of water quality of potentially affected ground-water resources. This information will provide the basis for evaluating potential effects of *in situ* leach extraction on the quality of local ground-water resources. Verify that a sufficient number of baseline ground-water samples are collected to provide meaningful statistics, that samples are spaced in time sufficiently to capture temporal variations, and that the chemical constituents and water quality parameters evaluated are sufficient to establish pre-operational water quality, including classes of use.

(5) Review the applicant's assessment of seasonal and, if data are available, the historical variability for levels of surface-water bodies and water levels or potentiometric heads in aquifers and ensure that sufficient time intervals have elapsed between measurements to allow assessment of seasonal variability.

(6) Verify that the applicant has provided information on past, current, and anticipated future water uses, including descriptions of local ground-water well locations, type of use, amounts used, and screened intervals.

In conducting an evaluation of ground-water activities, the reviewer should follow the reviews conducted by the state. Where appropriate, the evaluation should not duplicate state regulatory efforts. Although NRC must make its own independent findings, reviewers need not duplicate questions if a state or other federal regulatory agency has already addressed the issue. If the applicant response to questions from a state or other federal agency is submitted to NRC so that it becomes part of the license application to NRC, then the reviewer can use the information to prepare the technical evaluation report on ground-water issues.

2.7.3 Acceptance Criteria

The hydrologic characterization should establish a hydrologic conceptual model for the *in situ* leach site and surrounding region. The conceptual model provides a framework for the

applicant to make decisions on the optimal methods for extracting uranium from the mineralized zones, and to minimize environmental and safety concerns caused by *in situ* leach operations. Hydrologic characterizations that accomplish this objective are considered acceptable.

The characterization of the site hydrology is acceptable if it meets the following criteria:

(1) The applicant has characterized surface-water bodies and drainages within the licensed area and affected surroundings. Maps provided in the application identify the location, size, shape, hydrologic characteristics, and uses of surface-water bodies near the proposed site, including likely surface drainage areas near the proposed facilities. An acceptable application should also identify the zones of interchange between surface-water and ground-water.

(2) The applicant has provided an assessment of the potential for flooding and erosion that could affect the *in situ* leach processing facilities or surface impoundments. The staff recognizes that the flooding and erosion protection design of impoundments for *in situ* facilities may be relatively simple. This is true when impoundments are located near or on a drainage divide and little or no diversion of runoff is necessary to protect the impoundment side slopes from erosion. In such cases, it will be easy to demonstrate that no erosion to the slopes will occur. In flood-prone areas, however, it may be necessary to conduct surface-water and erosion modeling. Information regarding acceptable models may be found in NUREG–1623 (NRC, 1999). The reviewer should recognize, however, that the staff guidance (NRC, 1999) was prepared for use in evaluating a 1,000-year design life for large tailings impoundments, whereas the design life of the surface impoundments at *in situ* leach facilities is on the order of tens of years.

(3) The applicant has described the local and regional hydraulic gradient and hydrostratigraphy. The applicant has shown that subsurface water level measurements were collected by acceptable methods, such as American Society for Testing and Materials D4750 (American Society for Testing and Materials, 2001). Potentiometric maps are the recommended means for presenting hydraulic gradient data. These maps should include two levels of detail: regional and local. The regional map should represent the mineralized zone aquifer and should encompass the likely consequences on any affected highly populated areas. The local (site-scale) map should encompass the entire licensed area. If overlying and underlying aquifers exist, local-scale potentiometric or water surface elevation maps of these aquifers should also be included. These maps should clearly show the locations, depths, and screened intervals of the wells used to determine the potentiometric surface elevations. Alternatively, this information can be provided in separate maps and/or tables. The appropriate contour interval will vary from site to site; however, contour intervals should be sufficient to clearly show the ground-water flow direction in the ore zone and in the overlying and underlying aquifers. The number of piezometer elevation measurements used to construct each map should be sufficient to determine the direction of ground-water flow in the mineralized zone(s) and the overlying aquifer. To construct a regional potentiometric map, a reasonable effort should be made to consider as many existing wells as possible.

Hydrogeologic cross-sections are recommended for illustrating the interpreted hydrostratigraphy. These cross-sections should be constructed for the area within the license boundary. For very large or irregularly shaped well field areas, more than one cross section may be necessary. Cross sections must be based on borehole data collected during well installation or exploratory drilling. All significant borehole data should be included in an appendix. Staff should verify that, an adequate number of boreholes is used to support the assertion of hydrogeologic unit continuity, if shown as such in the cross sections.

The applicant should describe all hydraulic parameters used to determine expected operational and restoration performance. Aquifer and aquitard hydraulic properties may be determined using aquifer pumping tests for parameters such as hydraulic conductivity, transmissivity, and specific storage. Any of a number of commonly used aquifer pumping tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells. The methods or standards used to analyze pumping test data should be described and referenced: acceptable methods of analysis include use of curve fitting techniques for drawdown or recovery curves that are referenced to peer-reviewed journal publications, texts, or American Society for Testing and Materials Standards. It is important for the reviewer to ensure that where fitted curves deviate from measured drawdown, the applicant explains the probable cause of the deviation (e.g., leaky aquitards, delayed yield effects, boundary effects, etc.). For estimates of porosity, it is acceptable to use laboratory analysis of core samples, borehole geophysical methods, and analysis of the barometric efficiency of the aquifer (e.g., Lohman, 1979). The applicant should distinguish between total porosity estimated from borehole geophysical methods and effective porosity that determines transport of chemical constituents.

(4) Reasonably comprehensive chemical and radiochemical analyses of water samples, obtained within and at locations away from the mineralized zone(s), have been made to determine pre-operational baseline conditions. Baseline water quality should be determined for the mineralized and surrounding aquifers. These data should include water quality parameters that are expected to increase in concentration as a result of *in situ* leach activities and that are of concern to the water use of the aquifer (i.e., drinking water, etc.). The applicant should show that water samples were collected by acceptable sampling procedures, such as American Society for Testing and Materials D4448 (American Society for Testing and Materials, 1992).

For example, *in situ* leach operations are not expected to mobilize aluminum, and unless an ammonia-based lixiviant is used, ammonia concentrations in the ground water should not increase as a result of *in situ* leach operations. Therefore, little is gained by sampling these parameters. Studies have shown that thorium-230 is mobilized by bicarbonate-laden leaching solutions. However, studies have also shown that after restoration, thorium in the ground water will not remain in solution because the chemistry of thorium causes it to precipitate and chemically react with the rock matrix (Hem, 1970). As a result of its low solubility in natural waters, thorium is found in only

trace concentrations. Additionally, chemical tests for thorium are expensive, and are not commonly included in water analyses at *in situ* leach facilities.

The applicant should identify the list of constituents to be sampled for baseline concentrations. The list of constituents in Table 2.7.3-1 is accepted by the NRC for *in situ* leach facilities. Alternatively, applicants may propose a list of constituents that is tailored to a particular location. In such cases, sufficient technical bases must be provided for the selected constituent list.

Table 2.7.3-1. Typical Baseline Water Quality Indicators to be Determined During Pre-operational Data Collection

A. Trace and Minor Elements		
Arsenic	Iron	Selenium
Barium	Lead	Silver
Boron	Manganese	Uranium
Cadmium	Mercury	Vanadium
Chromium	Molybdenum	Zinc
Copper	Nickel	
Fluoride	Radium-226 and 228	
B. Common Constituents		
Alkalinity	Chloride	Sodium
Bicarbonate	Magnesium	Sulfate
Calcium	Nitrate	
Carbonate	Potassium	
C. Physical Indicators		
Specific Conductivity*		Total Dissolved Solids#
pH*		
D. Radiological Parameters		
Gross Alpha†	Gross Beta	

*Field and Laboratory determination.
#Laboratory only.
†Excluding radon, radium, and uranium.

At least four sets of samples, spaced sufficiently in time to indicate seasonal variability, should be collected and analyzed for each listed constituent for determining baseline water quality conditions. Some samples should be split and sent to different laboratories as part of a quality assurance program. Sets of samples should be taken with a minimum of a week or two between sampling to provide an indication of how the water quality of the aquifers changes with time. The applicant should document any variability in the ground-water flow rates or recharge that are observed in the collected data. Additional sampling to establish the natural cyclical fluctuations of the water quality is necessary if natural ground-water flow rates and recharge conditions vary considerably. Where perennial surface-water sources are present, surface-water quality measurements should be taken on a seasonal basis for a minimum of 1 year before implementation of *in situ* leach operations. Surface-water samples can be obtained by grab sampling and should be taken at the same location each time. The average water quality for each aquifer zone and the range of each indicator in the zone have been tabulated and evaluated. If zones of distinct water quality characteristics are identified, they are delineated and referenced on a topographic map. For example, since uranium rollfront deposits are formed at the interface between chemically oxidizing and reducing environments, water quality characteristics may differ significantly across the rollfront.

(5) The applicant has provided an assessment of seasonal and the historical variability for potentiometric heads and hydraulic gradients in aquifers and water levels of surface-water bodies. This assessment should include water levels or water potentials measurements over at least 1 year and collected periodically to represent any seasonal variability.

(6) The applicant has provided information on past, current, and anticipated future water use, including descriptions of local ground-water well locations, type of use, amounts used, and screened intervals. This information must be sufficient to evaluate potential risks to ground-water or surface-water users in the vicinity of the *in situ* leach facility.

For license renewals and amendment applications, most or all of the preceding acceptance criteria may previously have been met. Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.7.4 Evaluation Findings

If the staff's review as described in this section results in the acceptance of the site hydrology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the hydrologic site characterization information for the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.7.2 and acceptance criteria outlined in standard review plan Section 2.7.3.

The licensee has acceptably described the hydrology by providing (i) estimates of the local and regional hydraulic gradients, using potentiometric surface maps with acceptable contour intervals, including the mineralized aquifer and other overlying or underlying aquifers, and the likely consequences to affected populated areas; (ii) hydrologic cross-sections, based on an appropriate number of boreholes; (iii) acceptable comprehensive chemical and radiochemical analyses of water samples from in and near the mineralized zone(s) that define the pre-operational baseline water quality conditions; (iv) all hydraulic parameters used to determine expected operational and restoration performance; and (v) characterization of surface water in the *in situ* leach facility and nearby areas, including presentation of such information on maps. Zones of interchange between surface-and ground-water have been identified. The applicant has provided acceptable erosion protection against the effects of flooding from nearby streams and for drainage and diversion channels, such that the suggested criteria in NUREG–1620 (NRC, 2002) have been followed and that the design meets the requirements of 10 CFR Part 40, Appendix A.

Based on the information provided in the application, and the detailed review conducted of the characterization of the hydrology at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the site and associated conceptual and numerical models and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.7.5 References

American Society for Testing and Materials. "Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)." Test Method D4750-87. West Conshohcken, Pennsylvania: American Society for Testing and Materials. 2001.

———. "Standard Guide for Sampling Groundwater Monitoring Wells." Guide D4448-85a. West Conshohcken, Pennsylvania: American Society for Testing and Materials. 1992.

Crippen, J.R. and C.D. Bue. "Maximum Floodflows in the Conterminous United States." USGS Water Supply Paper No. 1887. Denver, Colorado: U.S. Geological Survey. 1977.

Hem, J.D. "Study and Interpretation of the Chemical Characteristics of Natural Water." USGS Water Supply Paper 1473. Denver, Colorado: U.S. Geological Survey. 1970.

Lohman, S.W. "Groundwater Hydraulics." USGS Professional Paper 708. Reston, Virginia: U.S. Geological Survey. 1979.

NRC. NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act." Rev. 1. Washington, DC: NRC. 2002.

U.S. Army Corps of Engineers. "Flood Hydrograph Package." HEC–1. Washington, DC: U.S. Army Corps of Engineers, Hydrologic Engineering Center. 1997a.

———. "Water Surface Profiles." HEC–2. Davis, California: Hydrologic Engineering Center. 1997b.

———. "Wave Runup and Wind Setup on Reservoir Embankments." ETL 1110-2-221. 1966.

U.S. Bureau of Reclamation. "Comparison of Estimated Maximum Flood Peaks with Historic Floods." Washington, DC: U.S. Department of the Interior. 1986.

2.8 Ecology

2.8.1 Areas of Review

The staff should review descriptions of the flora and fauna in the vicinity of the licensed area, their habitats, and their distribution. The review should include identification of important species that are (i) threatened or endangered, (ii) commercially or recreationally valuable, (iii) affecting the well-being of some important species within Criterion (i) or (ii), or (iv) critical to the structure and function of the ecological system or a biological indicator of radionuclides or chemical pollutants in the environment.

The review should include the inventory of the majority of the terrestrial and aquatic organisms on or near the site and their relative (qualitative) abundance, the quantitative abundance of the important species, and species that migrate through the area or use it for breeding grounds. The staff should review discussions of the relative importance of the proposed site environs to the total regional area for the living resources (potential or exploited).

For operations involving drying of yellowcake, disposal of waste or generation of hazardous effluents, the staff should examine data on the count and distribution of important domestic fauna, in particular cattle, sheep, and other meat animals that may be involved in the exposure of man to radionuclides. Important game animals should receive similar treatment. A map showing the distribution of the principal plant communities should be reviewed.

The staff should also review the discussion of species-environment relationships, including descriptions of area usage (e.g., habitat, breeding) for important species, life histories of important regional animals and aquatic organisms, normal seasonal population fluctuations and habitat requirements, and identification of food chains and other interspecies relationships, particularly when these contribute to prediction or evaluation of the impact of the facility on the regional biota. The staff should examine any information presented on definable pre-existing environmental stresses from sources such as pollutants, as well as pertinent ecological conditions suggestive of such stresses and the status of ecological succession. As appropriate, the staff should review a list of pertinent published material dealing with the ecology of the region and ecological or biological studies of the site or its environs currently in progress or planned.

2.8.2 Review Procedures

The reviewer should consult with the U.S. Fish and Wildlife Service using procedures in 50 CFR Part 402, "Interagency Cooperation—Endangered Species Act of 1973," as amended. The staff should review the descriptions and inventories of the flora and fauna in the vicinity of the site, including habitats and distribution. The review should include terrestrial and aquatic organisms on or near the site, and their relative (qualitative) abundance should be established. Particular attention should be given to species based on their relative importance to the community. The reviewer should determine that all important species have been identified. Important species should be a part of the larger inventory of species. If important species are determined to be present, the staff should evaluate any likely detrimental effects on the organism by the proposed facility and its operations.

The reviewer should determine that information on the various species is presented in two separate subsections: terrestrial ecology and aquatic ecology. The reviewer should also determine that the discussion of the species-environment relationships includes descriptions of area usage (e.g., habitat, breeding) for important species and discussions of life histories of important regional animals and aquatic organisms, including normal seasonal population fluctuations and their habitat requirements. Food chains and other interspecies relationships should be examined, particularly when these may bear on predictions or evaluations of the impact of the proposed facility on the stability of regional biota. The reviewer should also examine documentation provided for any pre-existing environmental stresses from sources such as pollutants, as well as pertinent ecological indicators suggestive of such stresses. A discussion of the status of ecological succession should be evaluated.

For any operation involving the drying of yellowcake, disposal of waste, or generation of hazardous effluents, the staff should review data on the number and distribution of locally significant domestic flora and fauna, in particular cattle, sheep, commercial fish, and other meat animals, and commercial crops that may be part of the food chain delivering radiation exposure to man. Important game animals should be treated similarly. A map showing the distribution and estimates of numbers of commercially significant species should be examined. Specific review guidance is provided in NUREG–1748 (NRC, 2001).

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.8.3 Acceptance Criteria

The characterization of the site ecology is acceptable if it meets the following criteria:

(1) Inventories of terrestrial and aquatic species are compiled by the applicant based on reports or databases of state or federal agencies (e.g, U.S. Fish and Wildlife Service, EPA).

Historical sitings of important species, as defined in the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982) should be included

in the inventory. If such reports do not exist, inventories should be prepared by the applicant based on a radius within which impacts are reasonably expected to occur. Documentation should be provided that inventories were prepared in consultation with appropriate local, state, and federal agencies to confirm the presence or absence of important species (especially threatened or endangered species). Inventories may be based on historical data, but should be updated to within 2 years of the time of application to establish current baselines.

(2) Inventories of locally significant domestic flora and fauna, in particular cattle, sheep, commercial fish, and other meat-producing animals and commercial crops are based on recent production figures from local, state, and federal agencies (e.g., U.S. Department of Agriculture).

The statistics should cover at least 3 years and have been conducted within 2 years of the date of the application to establish reasonable baselines. Important game animals should be treated similarly. A map showing the distribution and estimates of numbers of commercially significant species should be provided and may be combined with land use maps discussed in Section 2.2 of the standard review plan.

(3) The applicant has identified any endangered species as listed in 50 CFR Part 17, “Endangered and Threatened Wildlife and Plants.”

Any discussion should include nonpermanent inhabitants migrating through the area or using it for breeding grounds. The preservation of habitat, particularly for important species, should be a prime consideration. A map of the principal floral and faunal communities has been provided. Additional information can be found in 50 CFR Parts 401–453.

(4) The application provides a thorough description of the species-environment relationships for each important species identified within a radius where impacts are reasonably expected to occur. If no important species are identified within this radius, the application should plainly state so, and no additional review is necessary.

The application should take these relationships into account in providing a discussion of any likely detrimental effects that operation of the site may have on the species through changes in habitat, pollution, and aspects of the operations that may place stress on the species-environment relationship. Finally, the application should provide information regarding steps that will be taken to minimize the effect of operating the facility on the species-environment relationship.

(5) All sources of ecological information are documented in open file reports or other published documents. If data have been generated by the applicant, the documentation should provide a description of the investigations and data reduction techniques.

A list of pertinent published material dealing with the ecology of the region should be included. Any ecological or biological study of the site or its environs either in progress or planned should be described and referenced.

2.8.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the description of the site ecology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with ecology at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.8.2 and acceptance criteria outlined in standard review plan Section 2.8.3.

The licensee has described the ecology by providing acceptable (i) inventories of terrestrial and aquatic species, including threatened or endangered species listed in 50 CFR Part 17
(ii) inventories of locally significant domestic flora and fauna (e.g., cattle, sheep, goats),
(iii) discussions of important species found within a radius where impacts are reasonably expected to occur and estimations of their current and historical abundance, and
(iv) descriptions of the species-environment relationships for any important species.

Based on the information provided in the application and the detailed review conducted of the characterization of the ecology at the _____*in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the site ecology and associated conceptual and numerical models and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.8.5 References

NRC. NUREG–1748, “Environmental Review Guidance for Licensing Actions Associated with NMSS Programs.” Washington, DC: NRC. 2001.

———. Regulatory Guide 3.46, “Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining.” Washington, DC: NRC, Office of Standards Development. 1982.

2.9 Background Radiological Characteristics

2.9.1 Areas of Review

The reviewer should examine site-specific radiological data provided in the application including the results of measurements of radioactive materials occurring in important species, soil, air, and in surface and ground waters that could be affected by the proposed operations. The reviewer should examine the design of the pre-operational monitoring program, including which radionuclides are analyzed, sampling locations, sample type, sampling frequency, location and density of monitoring stations, and the detection limits.

2.9.2 Review Procedures

The reviewer should examine data from the pre-operational monitoring program with particular attention paid to the design of the monitoring program, the radionuclides monitored, the results, and the detection limits reported for each radionuclide in each sample medium. The reviewer should compare and contrast the pre-operational monitoring program as implemented against the guidance provided in Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980) and NUREG–5849 (draft), "Manual for Conducting Radiological Surveys in Support of License Termination" (Berger, 1992) or NUREG–1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.9.3 Acceptance Criteria

The characterization of the site background radiological characteristics is acceptable if it meets the following criteria:

(1) Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980). Air monitoring stations are located in a manner consistent with the principal wind directions reviewed in Section 2.5 of the standard review plan.

(2) Soil sampling is conducted at both a 5-cm [2-inch] depth as described in Regulatory Guide 4.14, Section 1.1.4 (NRC, 1980) and 15 cm [6 in] for background decommissioning data.

2.9.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the description of the site background radiological characteristics, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the characterization information concerned with the background radiological characteristics at the _____*in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.9.2 and acceptance criteria outlined in standard review plan Section 2.9.3.

Table 2.9.3-1. Standard Format for Water Quality Data Submittal to the NRC for Uranium Recovery Facilities
1. Water quality sampling techniques and analysis should be in accordance with U.S. Environmental Protection Agency (EPA) (1974) 2. All water quality data submitted to NRC should a. Be submitted in tabular form with the appropriate standards (i.e., EPA national interim primary drinking water regulations, livestock standards, baseline or excursion levels, or 10 CFR Part 20, Maximum Permissible Concentrations)[1] listed in the same table, for ease of data comparison. Methods of sampling and preserving and the laboratory utilized should be indicated in the table. The sampled depths, formation(s) sampled, water-level elevations and data measured, and distances from the tailings pond [2] or well field for each monitor should be noted in the table. b. Be submitted graphically to illustrate water quality and water-level elevation changes with time with applicable governing standards, EPA national interim primary drinking water standards and livestock standards, baseline or excursion levels, or maximum permissible concentrations[3] (whatever is appropriate), for the particular constituent on the graph. c. Include a short summary of the data interpretation, noting any anomalies, with an explanation. d. Water quality data reports should include a map that shows all water quality sampling points.
Reference: EPA. "Manual for Chemical Analysis of Water and Wastes". EPA–625–/6–74–003a. Cincinnati, Ohio: EPA, Office of Research and Development Publications. 1974. [1]10 CFR Part 20 liquid effluent control limits are specified in Table 2 of Appendix B and are not termed Maximum Permissible Concentrations. This table is a direct extraction from the EPA reference. [2]Tailings ponds do not exist at *in situ* leach facilities. This table is a direct extraction from the EPA reference. [3]10 CFR Part 20 liquid effluent control limits are specified in Table 2 of Appendix B and are not termed Maximum Permissible Concentrations. This table is a direct extraction from the EPA reference.

The licensee has acceptably established the background radiological characteristics by providing (i) monitoring programs to determine background radiologic characteristics that include radionuclides monitored, sampling frequency, and methods, location, and density; (ii) air quality stations located consistent with the prevailing wind directions; (iii) time periods for preoperational monitoring that allow for 12 consecutive months of sampling; and (iv) radiologic analyses of soil samples at 5-cm [2-in.] and 15-cm [6-in.] depths.

Based on the information provided in the application, and the detailed review conducted of the characterization of the background radiological characteristics at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the radiological background of the site and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.9.5 References

Berger, J.D. NUREG/CR–5849, “Manual for Conducting Radiological Surveys in Support of License Termination.” Washington, DC: NRC. 1992.

NRC. Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills.” Revision 1. Washington, DC: NRC, Office of Standards Development. 1980.

———. “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).” Revision 1. Washington, DC: NRC. 2000.

EPA. “Manual for Chemical Analysis of Water and Wastes.” EPA–625–/6–74–003a. Cincinnati, Ohio: EPA, Office of Research and Development Publications. 1974.

2.10 Other Environmental Features

2.10.1 Areas of Review

This review should include environmental site characterization information that does not clearly fall into any of the other subsections in Section 2 of the standard review plan. These will typically be site-specific, and may be used by the applicant to mitigate unfavorable conditions, or to provide additional information in support of the description of the proposed facility. Information that the applicant believes is important to establish the value of the site and site environs to important segments of the population is appropriately included in this subsection.

2.10.2 Review Procedures

The staff should consider environmental information provided in this section as auxiliary information to support an application for a given facility. The information should be considered in a site-specific context and should be consistent with the information provided in other sections of the application. Depending on the site-specific situation, there may be no information in this section of the application.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.10.3 Acceptance Criteria

The characterization of other site environmental features is acceptable if it meets the following criteria:

(1) It is consistent with information provided in previous subsections.

(2) Information is provided in a manner consistent with good scientific practice, is supported by objective data to the extent possible, and is relevant to the site under consideration.

(3) Information supports a determination that the *in situ* leach facility can be operated in a manner that will protect public health and safety and the environment.

2.10.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the description of other environmental features at the site, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the characterization information for other environmental features at the _____*in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.11.2 and acceptance criteria outlined in standard review plan Section 2.11.3.

The licensee has acceptably described any other important environmental features by providing information that is (i) consistent with other aspects of the site description, (ii) supported by objective data, (iii) relevant to the site under consideration, and (iv) supportive of a determination that the *in situ* leach facility can be operated while protecting public health and safety.

Based on the information provided in the application, and the detailed review conducted of the characterization of the other environmental features at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the other environmental features, supports associated conceptual and numerical models, and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis; and 10 CFR Part 40, Appendix A, Criterion 6(7), which provides requirements for control of non-radiological hazards.

2.10.5 References

None.