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CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION

ENVIRONMENTAL SURVEILLANCE PLAN

FOR

THE PROPOSED HANFORD HIGH LEVEL

NUCLEAR WASTE REPOSITORY

Encl. located in DCC

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AUGUST 1986

Council of Energy Resource Tribes
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EXECUTIVE SUMMARY

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As an "affected tribe" under the NWPA of 1982, the Confederated Tribes of the Umatilla Reservation (CTUIR) may be adversely affected by a permanent, high-level nuclear waste repository located at the candidate Hanford site. However, the extent and types of possible environmental and health impacts to the tribes cannot be comprehensively investigated until detailed environmental impact assessments are performed during the site characterization phase of the proposed repository program. In order for necessary environmental impact assessments to be performed and coordinated in a timely and orderly manner pursuant to Section 118 of the NWPA and to provide detailed review and comment upon the Environmental Impact Statement (EIS) following its preparation during the latter phases of the site charcterization program, it is essential to prepare the pertinent tribal plans for this process during Fiscal Year 1986.

Recognition and concern by the Umatilla Tribe about the magnitude and scope of the proposed high-level nuclear waste repository program at Hanford Site, Washington, led the tribe in Fiscal Year 1986 to request the Council of Energy Resource Tribes to assist them in developing an environmental surveillance program plan for the CTUIR possessory and usage rights area.

The major environmental surveillance program planning objectives and rationale are introduced in Section 1.0 of the plan. The salient factors affecting the level of tribal environmental surveillance also are outlined as part of the environmental surveillance program planning design process in Section 1.0.

One of the primary objectives of the CTUIR tribal environmental surveillance program is the collection of baseline data in the tribal possessory and usage rights area, bearing on the history of contaminant releases to the environment and existing levels of appropriately related parameters. The collection of baseline environmental data will, in turn, provide the necessary mechanism for the discovery of previously unconsidered pathways and modes of exposure within the CTUIR study area. An earlier scoping study performed by CERT has determined that serious inadequacies and gaps exist in the environmental baseline data base within the CTUIR possessory and usage area (CERT, 1984). Many of these discrepancies are pointed out in Section 2.0 of this program plan which provides a

brief overview of the natural environment of the vast CTUIR study area. Section 2.0 provides a brief description of the geology, hydrology, meteorology, climatology, soils, vegetation, fish and wildlife comprising the proposed study area.

The tribal environmental baseline monitoring program proposed by CERT to be initiated in Fiscal Year 1987, is developed in considerable detail in Section 3.0.

The design of the proposed CTUIR environmental baseline monitoring program is based upon the preliminary characterization of potential contaminant release scenarios previously developed by CERT (CERT, 1986). The initial phase of the environmental monitoring program is primarily intended to provide baseline information on existing background levels for selected radioactive and non-radioactive constituents throughout the proposed CTUIR study area. Therefore, a comprehensive tribal environmental data collection program is proposed in the areas of the atmospheric sciences, hydrology, soils, vegetation, fish, and wildlife within the proposed CTUIR study area. Data bases to be developed over the next two to three years are intended to complement existing data bases from various federal and state agencies. Detailed costs, including manpower, equipment, and sampling and laboratory analyses, are provided for the first year of the proposed monitoring program in Section 3.0 of this plan. An outline of the proposed project organization to implement the monitoring activities is also provided. Section 3.0 of the monitoring plan concludes with a proposed schedule of major activities with appropriate activitiy milestones for Fiscal Year 1987.

Another major objective of the CTUIR tribal environmental surveillance program is the assessment of potential environmental and human health impacts in the CTUIR possessory and usage rights area as a consequence of the DOE high-level nuclear waste repository at the proposed Hanford Site.

During Fiscal Year 1986, CERT identified and characterized the major elements necessary to perform systematic risk assessments related to the foregoing Hanford high-level nuclear waste repository program. A summary of the major results, conclusions, and recommendations of these studies is presented in Section 4.0 of this program plan. The candidate release scenarios are proposed to be developed from the two major categories of possible contaminant release: (1) transportation of high-level nuclear waste through the CTUIR study area to the waste repository, and (2) site preparation, construction, operation, closure, and permanent storage of the high-level waste at the permanent repository location.

A schedule for proposed major activities and associated activity milestones for the planned predictive tribal environmental impact assessment studies for Fiscal Year 1987 conclude Section 4.0 of the tribal environmental surveillance program plan.

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1.0 INTRODUCTION

As an "affected tribe" under the Nuclear Waste Policy Act (NWPA) OF 1982, both the natural environment and the tribal population of the CTUIR may be adversely affected by the development of a permanent, high-level nuclear repository program at Hanford Site, Washington. However, the extent and types of potentially deleterious environmental impacts to the tribe cannot be comprehensively investigated until detailed environmental impact assessments are performed during the site characterization phase of the proposed repository program. In order for the necessary environmental impact assessments to be performed and coordinated in a timely and orderly manner pursuant to Section 118 of the NWPA and to review and comment upon the Environmental Impact Statement (EIS) following its preparation by DOE during the latter stages of the site characterization process, it became essential to prepare the pertinent tribal plans for this activity during Fiscal Year 1986.

Therefore, recognizing the vast areal extent of its possessory and usage rights area, the Umatilla Tribe has requested the Council of Energy Resource Tribes to assist them in their efforts to develop a plan for conducting environmental surveillance of the proposed high-level nuclear waste repository program at Hanford Site, Washington.

1.1 <u>TRIBAL ENVIRONMENTAL SURVEILLANCE PROGRAM PLANNING OBJECTIVES AND RATIONALE</u>

The major or primary objectives of the CTUIR tribal environmental program are outlined in their approximate order of importance as follows:

- Collection of baseline data bearing on the history of releases to the environment and existing levels of appropriately related parameters, especially with the intent of discovering previously unconsidered pathways and modes of exposure.

- Evaluation of the adequacy and effectiveness of the containment and effluent control systems applied to facilities and operations at the proposed Hanford Repository Site as well as other major nuclear facilities on the Hanford Reservation.

- Detection of rapid changes and evaluation of long-term trends of contaminant concentrations in the environment, with the intent to detect control system failure or lack of proper control of releases and to initiate appropriate actions.

- Assessment of either the actual or potential doses to man from radioactive materials or radiation released to the environment as a result of the DOE high-level nuclear waste repository program and the estimation of the probable limits of such doses.

- Maintenance of a data base and capabilities for rapid evaluation and response to unusual releases of radioactivity.

- Detection and evaluation of both radioactive and non-radioactive contaminants from other major sources on the Hanford Reservation and from off-site sources in order to distinguish and compare the results of various site operations.

- Documentation of DOE's compliance with applicable regulations and legal requirements concerning contaminant releases to the environment from the proposed Hanford repository site.

Despite the third statement above, the time lag and generally lower concentrations in most environmental measurements make primary reliance on an environmental measurement as an action signal unwise other than for purposes of further investigation. With the exception of long-term accumulation of contaminants from source terms too dilute to be conventionally measured, all environmental measurements should be considered as an important supplement to effluent monitoring or other repository facility or process measurements. In practice, environmental measurements are vital, in part to demonstrate compliance with the stated objectives and in part because prior knowledge of the eventual fate of every potential contaminant released is inevitably incomplete. Measurements representing as much as possible the actual exposure vectors to people should therefore provide a more accurate, though less precise, environmental dose estimate. For example, in the extreme for radioactive contaminants, the latter would call for extensive dosimeter use by, and in-vivo monitoring of, the tribal population—a solution which would probably not be considered practical on a routine basis.

Therefore, responsible management for the tribal environmental surveillance program will be confronted with numerous decisions as to the relative reliance on tribal environmental versus DOE onsite effluent measurements, as well as to the specific locations in the exposure pathways at which measurements are most appropriately made. Similarly, tribal decisions will be mandated for environmental measurements included in the routine, baseline monitoring program for purposes other than predictive estimation of tribal population radiation doses; e.g, trend evaluation and general tribal interest. Since these judgments will be heavily weighted by site-specific factors related to the site characterization processes, the associated high-level waste transportation system to the site, and the engineering design of the repository, the environmental surveillance program must be designed to reflect the evolution of the overall high-level nuclear waste repository program at the proposed Hanford Site.

1.2 TRIBAL ENVIRONMENTAL SURVEILLANCE PROGRAM PLANNING DESIGN PROCESS

Several salient factors which will affect the relative level of tribal environmental surveillance and, to some extent, the points at which measurements are to be made are:

- The potential hazard of the materials or contaminants released, considering both quantities and relative radiotoxicities.
- The extent to which both on-site facilities operations and the high-level nuclear waste transportation operations are routine and unchanging.
- The need or requirement for supplementing and/or complementing on-site effluent monitoring at the proposed Hanford Site.
- The size and distribution of the potentially exposed tribal population.
- The costs and cost-effectiveness of increments to the environmental surveillance program.

- The availability of measurement techniques which will provide sufficiently sensitive comparisons with applicable regulatory standards and baseline or "background" environmental monitoring measurements.

- The availability of predictive mathematical modeling methods to assess credible contaminant release scenarios and their potential environmental and human-health impacts to the tribal population and the tribal possessory and usage rights area.

A generic procedural flow design for an environmental surveillance program design process is presented in Figure 1-1 as an aid to placing the required data inputs and the environmental pathway analysis procedures in the proper relationship to program planning. In Figure 1-1, rectangles indicate data inputs, diamonds procedural steps. The many different kinds of data that must either be provided or estimated are apparent. Both the magnitude and complexity of the foregoing relationships are further illustrated in Figure 1-2, which depicts the detailed radiation dose calculation procedure that must be incorporated into a predictive mathematical model for estimates of environmental concentrations.

Since all the major radiation regulatory standards currently promulgated are given in terms of a radiation dose to people, the environmental program planning process must be addressed to the sampling, direct measurement, and/or predictive mathematical modeling of critical environmental pathways which may contribute to the radiation exposure to the public. In this context, the "critical" path (nuclide, organ, population group) is defined according to standard usage as the pathway providing the largest percentage of the applicable dose criterion. Selection of locations, frequency, media, and nuclides to be measured, and measurement methods to be used for critical pathway surveillance provides the basic requirements for the environmental surveillance program. To these will be added any special monitoring requirements, including trend indicators and those additional quality assurance samples, measurements, and/or mathematical analyses which should be recorded so that the purpose and any limitations or interpretations of results will be clear.

In general, two major transport media, air and water, are of primary concern in characterization of environmental concentrations derived from contaminant releases for

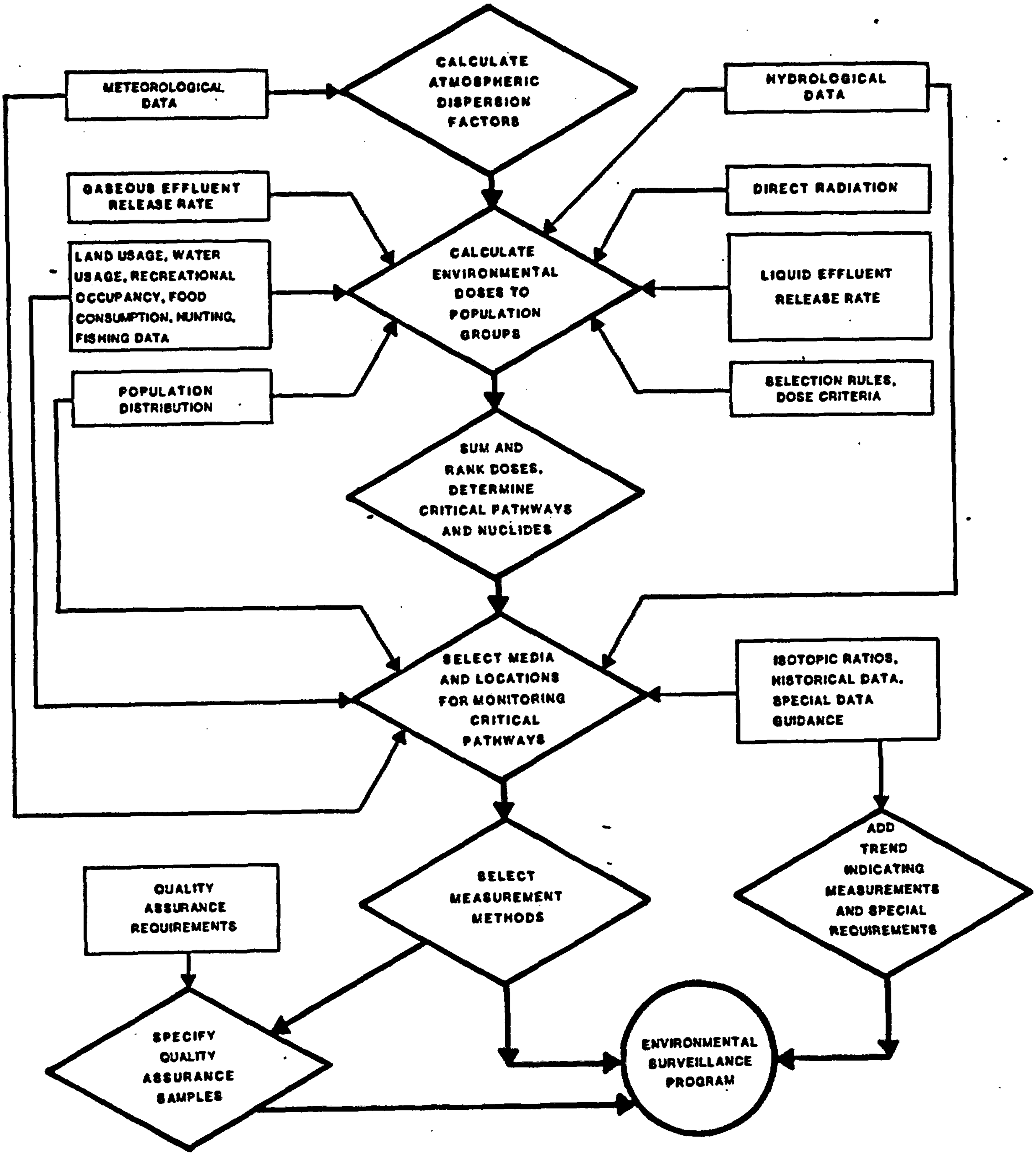

Figure 1-1. TRIBAL ENVIRONMENTAL SURVEILLANCE PROGRAM DESIGN PROCESS

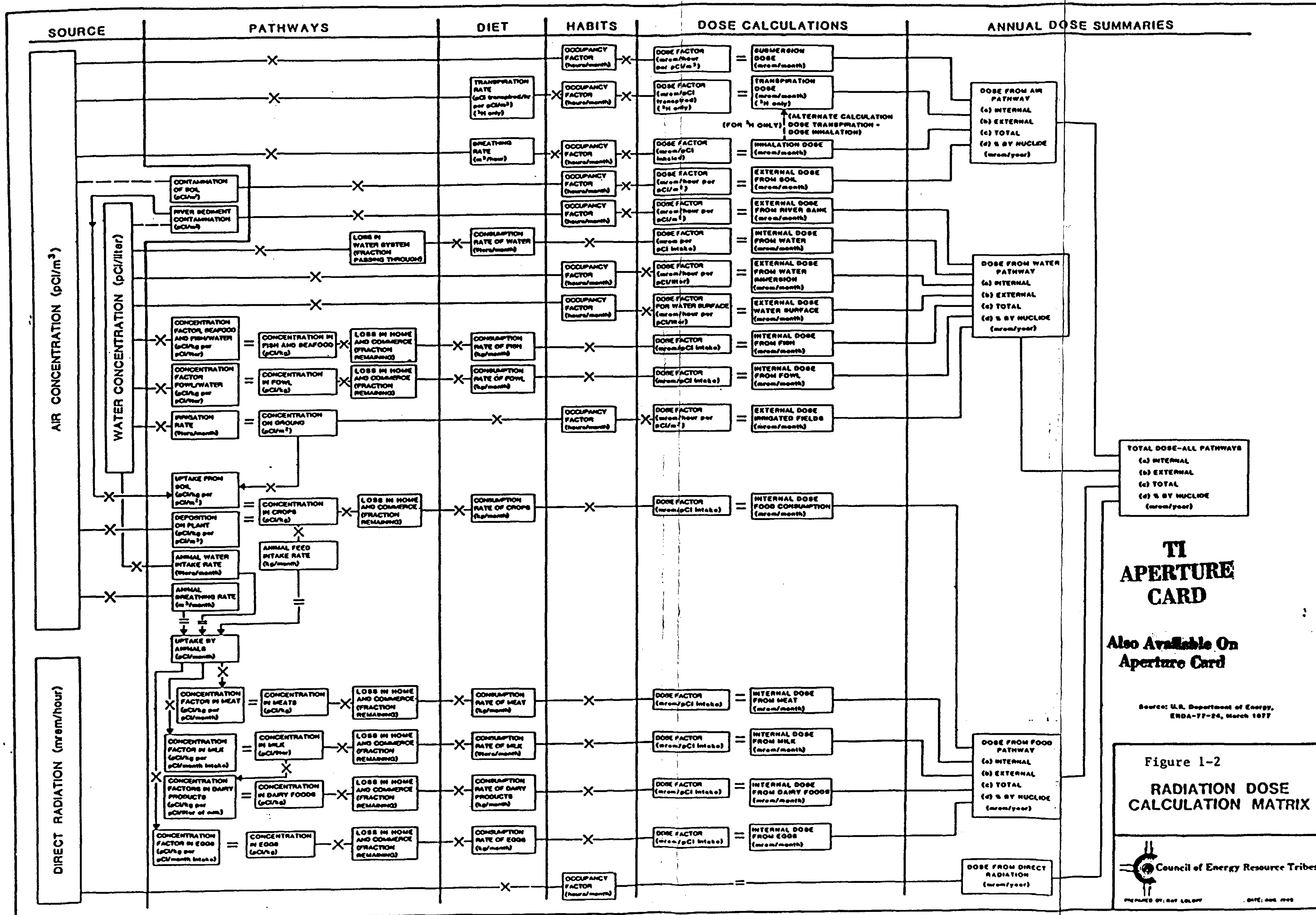

Figure 1-2

RADIATION DOSE CALCULATION MATRIX

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the tribal environmental surveillance program as shown graphically in Figures 1-3 and 1-4. Figure 1-3 depicts the major pathways of atmospheric routing from contaminant releases irrespective of the specific release scenario. Similarly, Figure 1-4 illustrates the major pathways of hydrologic routing from most contaminant release scenarios.

Due to the basic requirements for the collection and analysis of at least 2 to 3 years of environmental baseline data prior to the preparation of the aforementioned EIS it is timely that Tribe develop environmental monitoring plans in Fiscal Year 1986 in order to initiate sample and data collection in Calendar Year 1987. The necessity for this activity schedule is reflected in the current major milestone timelines for the first high-level nuclear waste repository program shown in Figure 1-5 which provides for an EIS in Calendar Year 1990, followed by a final site selection in 1991, an NRC license in 1994, leading to the initiation of operations for the first repository by 1998.

Therefore, the requirements for the tribal baseline environmental monitoring programs are presented in Section 3.0 of this planning document, following an overview of the major features of the natural environment included within the possessory and usage rights area of the Umatilla Tribe in Section 2.0. Planning activities related to the development and application of tribal environmental impact assessment methodologies are presented in Section 4.0.

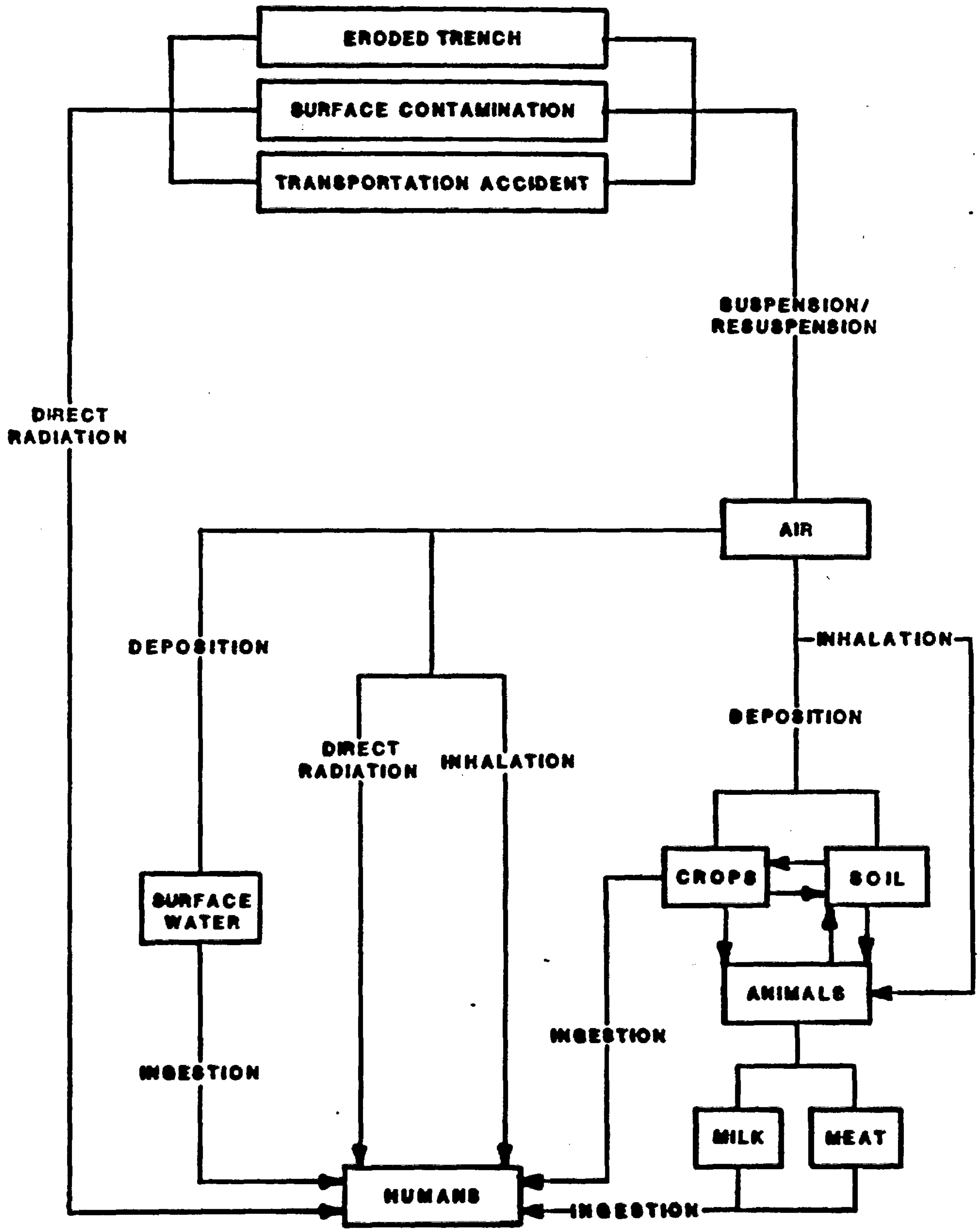


Figure 1-3. MAJOR PATHWAYS OF ATMOSPHERIC ROUTING

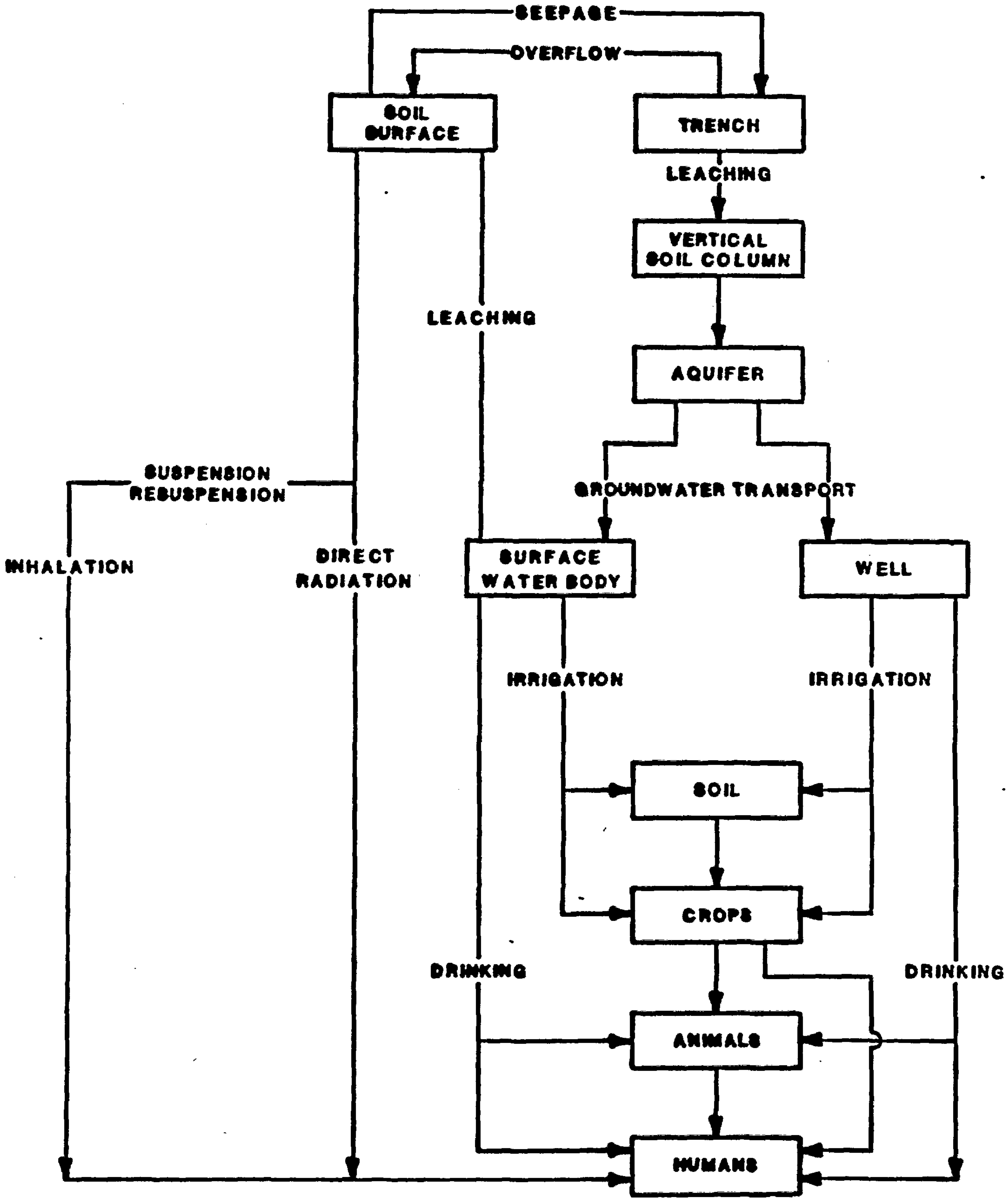


Figure 1-4. MAJOR PATHWAYS OF HYDROLOGIC ROUTING.

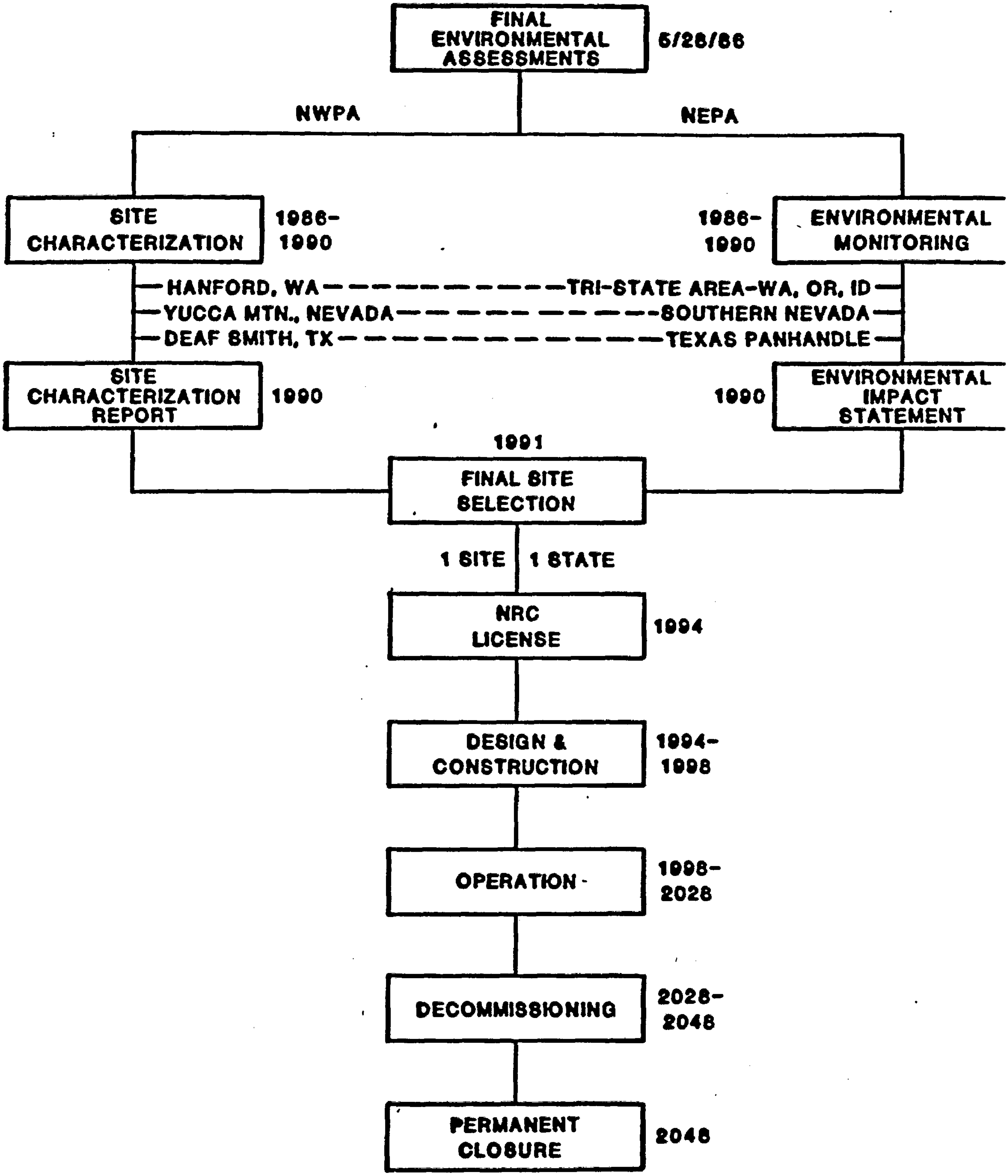


Figure 1-5. MAJOR MILESTONES FOR FIRST REPOSITORY - HIGH-LEVEL NUCLEAR WASTE PROGRAM

2.0 STUDY AREA OVERVIEW

The CTUIR study area encompasses approximately 10,000 square miles of southeastern Washington, and northeastern Oregon. This area includes the Umatilla Reservation and the broader ceded lands area. In addition, the main stem of the Columbia River is included. Justification for the delineation of such a study area is two-fold: (1) the study area is essentially the same as that documented in the CTUIR Scoping Study (CERT, 1984) and (2) combined with the study area outlined for the Nez Perce a regional data base can be developed to assess the potential impacts of the potential siting of a high-level nuclear waste repository at the Hanford Site, Washington. Figure 2-1 and Maps 2, 3, and 4 illustrate this proposed study area in relationship to the ceded lands of the Nez Perce and Yakima.

It is reasoned that by developing a regional data base in conjunction with the Nez Perce Tribe and the Yakima Tribe and the states of Washington and Oregon that the majority of this area should be adequately defined.

The following is an overview of the proposed study area. Presented in this section are brief summations of the proposed major topical activities by discipline that comprise the proposed CTUIR tribal environmental surveillance plan.

2.1 GEOLOGY

The following presents a brief overview of the physiography, lithology, and structure of the CTUIR study area. A more detailed summation of the geology is presented in the CTUIR Scoping Study (CERT, 1984).

2.1.1 Physiography

The CTUIR study area encompasses approximately 10,000 square miles of southeastern Washington and northeastern Oregon. As illustrated in Figure 2-1, most of the study area

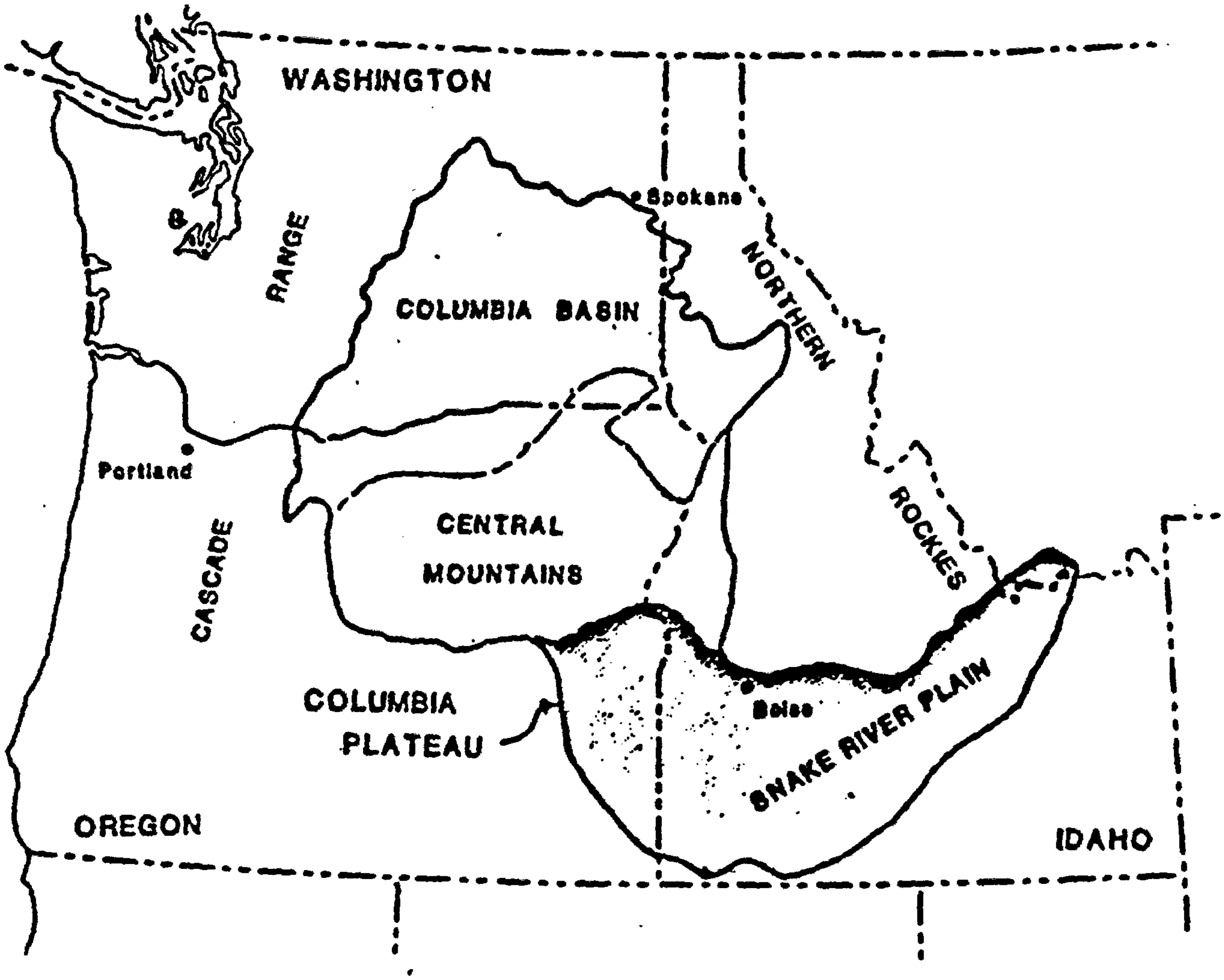


Figure 2-1. PHYSIOGRAPHIC PROVINCES OF THE NORTHWEST

lies within the Columbia Plateau Physiographic Province, with a small portion in the southeast belonging to the High Lava Plains Province (Fenneman, 1932). The High Lava Plains Province will not be discussed due to its relatively small areal extent within the study area and its distance from the proposed repository and major transportation routes.

The study area lies entirely within the Columbia River drainage basin. As shown in Figure 2-2, major drainages in this basin include the Columbia, Yakima, Snake, Walla Walla, Grande Ronde, Powder, Burnt, Malheur, John Day, and Umatilla Rivers. The majority of agricultural activities for the study area occur in the lowlands adjacent to these major rivers.

Two subdivisions of the Columbia Plateau drainage basin. As shown in Figure 2-2, major drainages in this basin include the Columbia, Yakima, Snake, Walla Walla, Grande Ronde, Powder, Burnt, Malheur, John Day, and Umatilla Rivers. The majority of agricultural activities for the study area occur in lowlands adjacent to these major rivers.

Two subdivisions of the Columbia Plateau Province are represented in the study area, the Blue Mountains and the Walla Walla Valley. These may be described as follows:

BLUE MOUNTAINS. According to Hogenson (1964), the Blue Mountains may be divided into two components, the Blue Mountain upland and the Blue Mountain slope. The uplands have been eroded by streams which range from youthful with steep valley walls to more mature, rounded hills which lie on the borders of the upland area. The upland area has a relief of over 3,600 ft. with elevations ranging from 3,500 ft. above mean sea level (amsl) at Cabbage Hill to more than 7,100 ft. amsl at the crest of Mount Fanny (Hampton and Brown, 1964). The Blue Mountain uplands form the headwaters for most of the major streams and rivers which drain the study area south of the Columbia River. The Blue Mountain slope consists of those areas which make up the gentle, maturely dissected slopes east and west of the Blue Mountain uplands.

WALLA WALLA VALLEY. The remainder of the study area within the Columbia River Plateau lies within the Walla Walla Valley which is bounded by the Horse Heaven Hills to the north and the Blue Mountain slope to south and east. It consists of lowlands and plans which are gently rolling and slightly dissected. These areas consist of water- and wind-laid deposits at lower elevations; dissected glacial lake deposits at moderate elevations

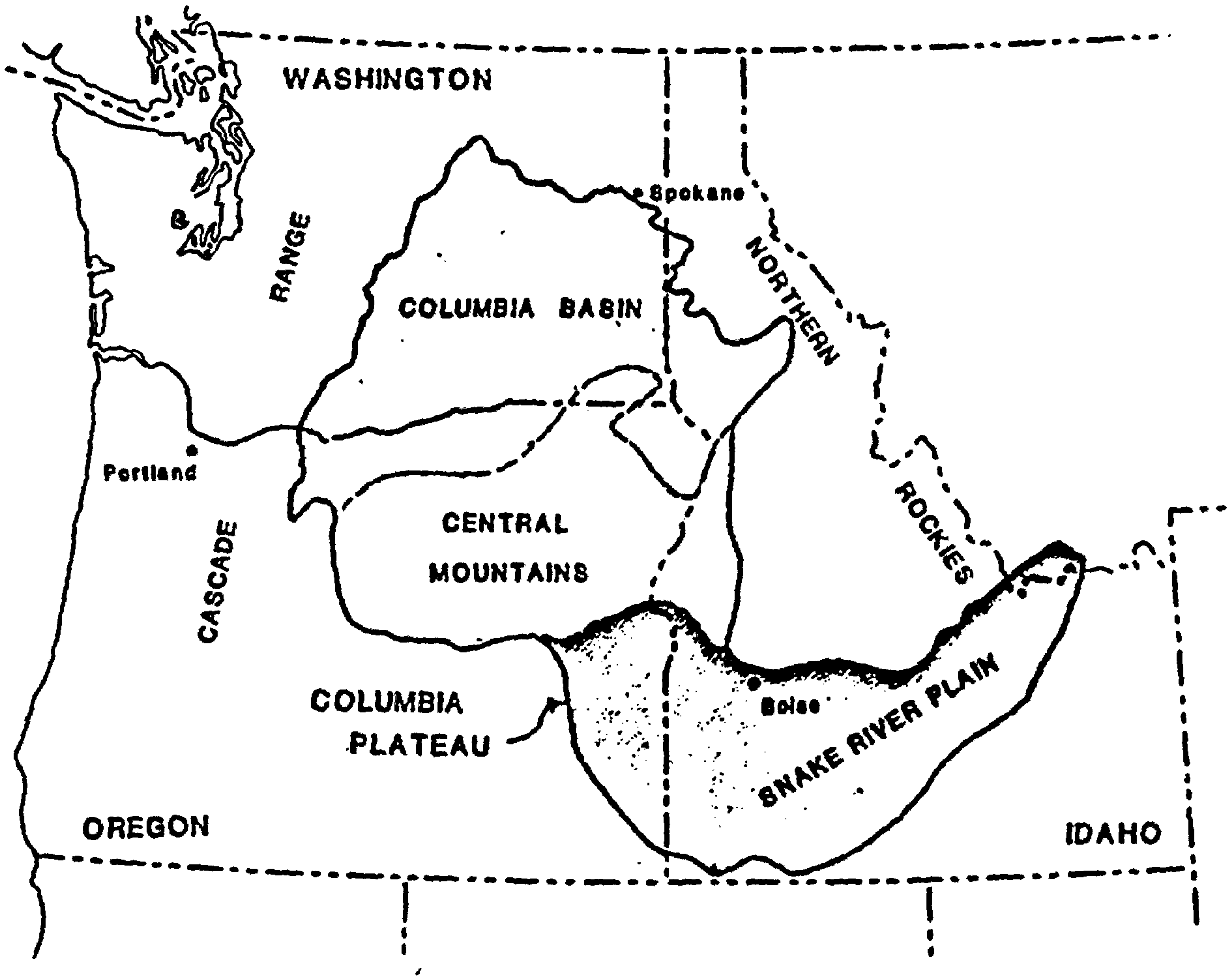


Figure 2-2. PHYSIOGRAPHIC PROVINCES

(750 ft. to 1,150 ft. amsl); and loess-covered, youthfully dissected, rolling plains above 1,150 ft. (Hogenson, 1964).

2.1.2 Lithology

The study area lies within the Columbia Plateau Geologic Province which encompasses more than 50,000 square miles of eastern Washington, eastern Oregon, and northwestern Idaho. The study area is generally underlain by (from oldest to youngest): pre-Tertiary rocks; Tertiary units, including the Clarno Formation, the Columbia River Basalt Group, and Pliocene sedimentary deposits; and windblown silt, volcanic ash, and fluvial deposits of Quaternary age. The following descriptions of these deposits are based on work done by Hogenson (1964) and other investigators.

PRE-TERTIARY ROCKS. In the southern portion of the Blue Mountains, metamorphic and intrusive rocks are exposed. The metamorphic rocks consist of gneisses and schists intruded by small bodies of granite, pegmatite, and ultrabasic rocks. These metamorphic rocks are incontact with a massive intrusion of norite and quartz diorite.

TERTIARY ROCKS. The Tertiary rocks consist of three units: the Clarno Formation, the Columbia River Basalt Group, and unconsolidated to semiconsolidated Pliocene deposits. These may be delineated as follows:

CLARNO FORMATION. Volcanic and sedimentary rocks of the Eocene-age Clarno Formation outcrop in the southern Blue Mountains. The basal portion of this formation consists of sandstone, micaceous shale, and siltstone. The upper portion contains several lightbrown to gray lava flows, in addition to sandstones and shales.

COLUMBIA RIVER BASALT GROUP. Most of the eastern half of the study area is underlain by an extensive sequence of dark-colored, well-stratified volcanic rocks. These rocks originated as lava flows during Miocene and early Pliocene time (6 to 16 million years before present; Gunthier, 1977). These units comprise the Columbia River Basalt Group, which underlies the Columbia Plateau.

The Columbia River Basalt Group consists of numerous individual lava flows, which range from a few feet to over three hundred feet in thickness. These basalts are fine-grained materials, rich in iron minerals, and poor in magnesium minerals, or tholeiitic. The

cooling history of each lava flow is reflected in the characteristics of that flow. typical flow consists of a bottom zone of dense, finely crystalline basalt which grades upward into a more massive, even-textured basalt (Gonthier, 1977). The basalt is commonly fractured by vertical, widely spaced cooling joints.

Well-developed basalt flow interiors consist of a central entablature and an adjacent colonnade. The entablature consists of rock broken by variably oriented small columns. The colonnade structure is comprised of well-formed, hexagonally shaped, vertical columns.

The upper portion of a massive basalt flow has numerous holes, or vesicles, formed by gas bubbles trapped during solidification. This zone usually has an irregular surface due to erosion and may be highly porous, brecciated, and blocky. Thin beds of tuff, ash and fluvial sediments from erosion may overlie the flow.

Basalt flows vary laterally in thickness, texture, and structure. A typical flow in the study area is between 30 and 50 feet thick. The hundreds of individual flows are combined into five formations, based on similar geochemical and depositional characteristics. These are (in descending order): the Saddle Mountain, Wanapum, Grande Ronde, Imnaha, and Picture Gorge Basalts. The upper three units underlie the Pasco Basin, while the lower three units are restricted to the extreme southwestern and southern margins of the study area (CERT, 1984).

PLIOCENE DEPOSITS. Pliocene deposits, consisting of unconsolidated to semiconsolidated sand, gravel and clay, underlie portions of the study area. These deposits represent alluvial fans formed by the erosion of the Blue Mountains. According to Hogenson (1964), these deposits are termed fanglomerate.

QUATERNARY DEPOSITS. There are four basic types of Quaternary deposits found within the study area: Pleistocene-age glaciofluvial and lucustrine deposits, the Palouse Formation, volcanic ash, and alluvium. These deposits are described in the following paragraphs:

GLACIAL DEPOSITS. The Pleistocene-age glacial and fluvial deposits are scattered throughout the study area and consist of sand and gravel. Interbedded with these coarse-grained deposits are fine-grained lake deposits.

PALOUSE FORMATIONS. The Palouse Formation, which is also of Pleistocene age, is a windblown silt (loess) that covers most of the study area. The loess is usually less than 4 feet thick and thins towards the Blue Mountains. The Palouse formation may have been derived from sediments deposited in an ancient glacial lake. This lake formed by ice damming of the Columbia River in northern Idaho or Montana.

VOLCANIC ASH. Thin deposits of volcanic ash also occur within the study area. These ash beds are generally grayish white to white, very fine grained, uniformly textured, and usually less than five feet thick. Prevailing winds probably blew the ash eastward during the eruptions of the volcanoes of the Cascade Range.

ALLUVIAL DEPOSITS. Alluvial deposits are found in most stream valleys, with the most extensive deposits found along the major rivers. The alluvium consists of unconsolidated sand and gravel with lesser amounts of silt, but its composition varies along any stream course. Extensive alluvial deposits on and near the reservation are found along the Clearwater River and Lapwai Creek. In the Clearwater River Valley, the alluvium varies from 10 to 30 feet thick along most of its length.

2.1.3 Structure

As outlined in the Scoping Study (CERT, 1984), the study area lies within three tectonic subprovinces within the Columbia Plateau: the Yakima Fold Belt, the Palouse Subprovince, and the Blue Mountains (Figure 2-3).

YAKIMA FOLD BELT. The Yakima Fold Belt, in which the Hanford Reservation lies, consists of a west-trending series of narrow, asymmetrical, anticlina folds separated by broader synclinal downwarps. The Pasco Basin is one of these synclinal features, formed as a result of north-south compressional forces. Within this subprovince, faulting has also occurred parallel to the folds. In some cases, these faults are evident from mapping of surficial deposits and represent relatively recent fault movement. The Olympic

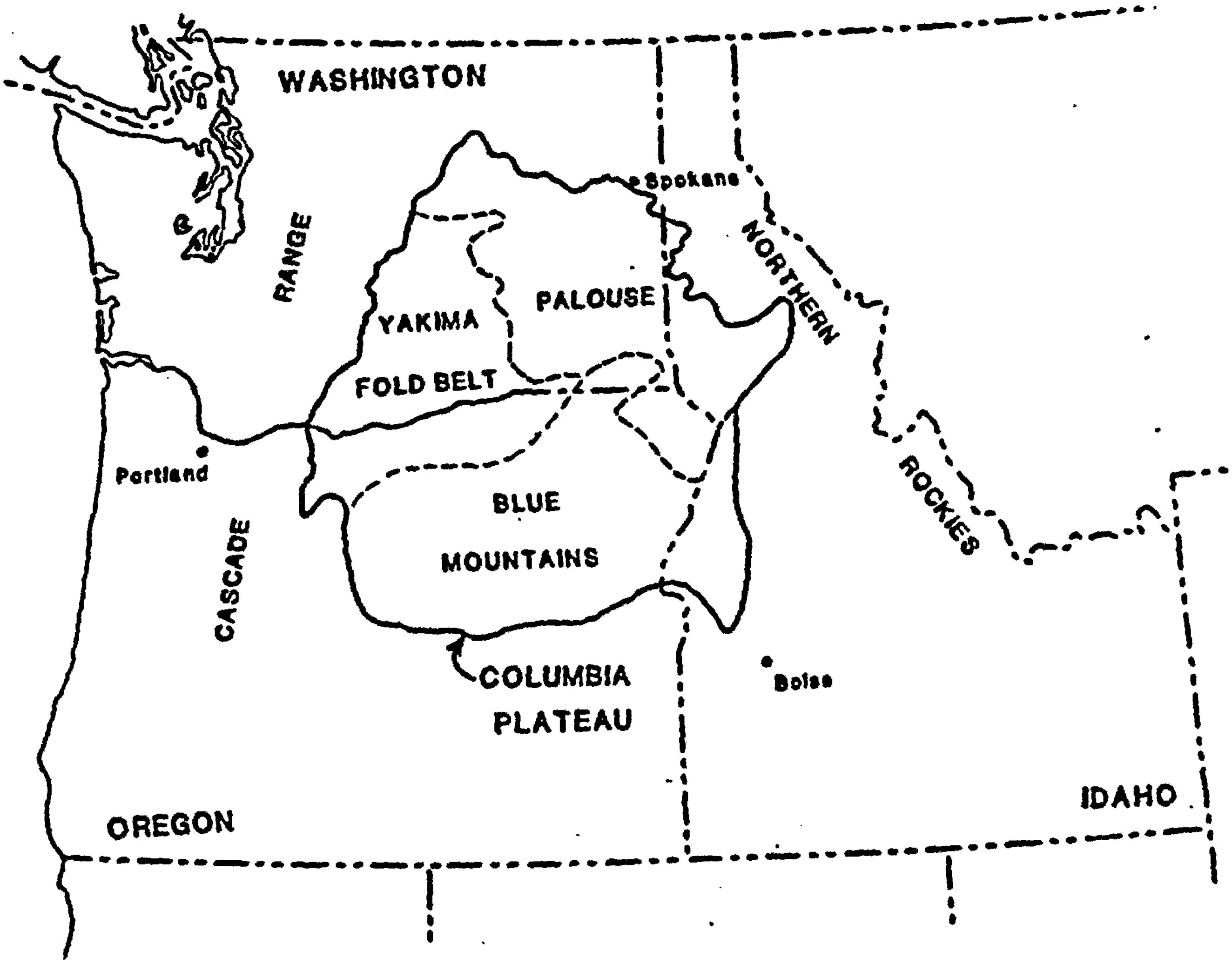


Figure 2-3. GEOLOGIC PROVINCES OF THE NORTHWEST

Wallowa Lineament (OWL), a major southeast-trending structural belt, and two of its components, the Cle Elum-Wallula deformed belt (CLEW) and the Rattlesnake-Wallula Alignment of faults (RAW), occur within this subprovince.

PALOUSE SUBPROVINCE. The Palouse Subprovince is a gently west-dipping monocline with low-amplitude, northwest-trending folds (CERT, 1985). Unlike the other subprovinces, the Palouse Subprovince contains relatively few closely spaced folds and faults. This suggests that this subprovince has been subjected to less intense compressional forces than the subprovinces to the west, which were located nearer the continental margin. One unusual structural feature of the Palouse is an east-west trending, assymetrical, faulted anticline called by Myers and others (1979) the Lewiston Structure. This structure drapes the Columbia River basalts over a fold resembling a south-dipping monocline, which causes the same units to be 2,000 feet lower in elevation in the Lewiston Basin than to the north in the Moscow area.

BLUE MOUNTAINS. The Blue Mountains Subprovince is a northeast-trending anticlinorium caused by block uplift during the early deposition of the Columbia River Basalts. The Blue Mountain Anticline is the major tectonic feature of this subprovince. The western slope of the Blue Mountains is underlain by the northwest limb of the Blue Mountain Anticline. The Blue Mountain upland is the nearly horizontal, platform-like crest of the broad anticline. The anticlinal axis is interrupted in many places by steeply-dipping, northwest-trending normal faults.

2.2 CLIMATOLOGY AND METEROLOGY

A brief overview of the climatological and meteorological relationships between the Hanford Site and the possessory and usage rights area of teh Umatilla Tribe is presented in this section to provide necessary background for development of the proposed tribal environmental plan. The general regional climatology and meteorology is discussed in Section 2.2.1. This is followed by a presentation of climatological and meteorological data available in the proposed CTUIR study area as shown in Map 3.

2.2.1 Regional Climatology and Meteorology

The general region identified in Map 3 covers an extensive surface area of approximately 41,000 square miles with elevations varying from 700 ft. to almost 10,000 ft. above sea level. Although terrain will cause varying localized differences in climate, a number of general observations can be made.

The climate of the region encompassing the Umatilla Reservation is influenced by a number of factors. The major factor influencing the regional climate is the location and orientation of the mountain ranges which surround and are within the study area. The Cascade Range located to the west of the region reduces the amount of precipitation available from the cool, moist, eastward- moving storms and air masses generated off of the Pacific Coast. Due to the effect of orographic lifting (eastward moving air being condensed and cooled as it is forced up the west side of the Cascade Range) well over 50% of the precipitation is removed from the resulting air mass. Consequently, as the prevailing westerly winds carry this drier air mass down the east side of the Cascades, the air warms and expands creating arid conditions. Also, the Cascade Range, with elevations exceeding 14,000 feet, prevents some of the mild cooler air emanating from the Pacific Ocean from reaching the region, causing warmer temperatures in the area.

The Cascades and the Rocky Mountains located north of the region shield the large Columbia Basin portion of the region from some of the winter season's cold air masses travelling from north to south out of Canada. In addition, in a manner very similar to that discussed for the Cascades, the northern mountains can tend to reduce any winter moisture associated with either cool Canadian air masses or storms generated from the prevailing Aleutian Low.

Finally, the gradual increase in elevation from west-to-east of the Palouse-Blue Mountains area, culminating east of the Nez Perce Reservation with the Rocky Mountains influences the eastern portion of the region. The prevailing westerly winds are forced up the west slope of these mountains, taking what available moisture is left out of the air mass. Also, temperatures in the eastern portion of the region will decrease with increasing elevation and the tendency for more frequent occurrences of cold Canadian air.

Although the various mountain ranges surrounding the region strongly influence the climate, the latitude of the region, the location of the region with respect to storm tracks, and the location of the region with respect to major bodies of water can also influence the regional weather. A range in regional latitude of 46°N to 47°N limits the amount of available solar radiation in the winter to heat the surface, causing cool to cold conditions. In the summer, the opposite is true causing hot to very hot conditions.

The prevailing storms track west to east (or sometimes north to south in the winter) in the region. The primary generator of such storms is the large low pressure system which forms in the fall/winter over the Aleutian Islands (the Aleutian Low) and lasts through spring/winter. This results in more precipitation occurring on a regional basis than during the summer.

The Pacific Ocean is a major source of precipitation and cool moderating air masses for the Pacific Northwest. Even though the region is somewhat shielded by the Cascade Range from the full impact of this source of moisture and cool air, the region is affected by the Pacific air masses either partially or totally on occasions when a major Pacific storm hits the region.

Therefore, the resulting climate of the region comprises the features of an arid-continental climate with the occasional influence of a humid-maritime climate. Precipitation amounts vary across the region from the arid conditions of about 5-10 in/yr in the basin area, to the semi-arid conditions of the Palouse of around 10-20 in/yr; and to the relatively humid conditions in the eastern mountains of the region of 40 in/yr or more.

Temperatures also vary from very hot conditions in the lower elevations of the basin area to more moderating temperatures in the eastern mountains. High temperatures over 110°F have been measured in the basin and low temperatures exceeding -40°F have been measured in the eastern portion of the region. Average annual temperatures for most locations in the region are approximately 50°F.

Local surface winds in the region are extremely variable normally reflecting terrain features. Annual average winds are usually moderate to light. However, gusty surface winds, associated with either thunderstorms or frontal passages can occur. Given the region's topographic variability, local winds are probably characterized as valley-induced

wind systems. The nocturnal cooling of ridges results in downslope drainage along river valleys. The flow of this cold air over the valley floor underlies warmer air aloft, which is usually flowing from the west. If the valley ridges are sufficiently warmed, nighttime drainage is replaced by up-valley air. Whether or not this occurs, is dependent upon the balance of daytime radiational heating and nighttime radiational cooling.

The region has a high frequency of near-calm wind conditions and a light to moderate frequency of storms. Surface winds are predominantly downslope in the mornings, with speeds generally less than 10 mi/hr, although gusts of 40 to 50 mi/hr or more are common.

Upper level winds, which are not as affected by terrain, are more uniform and follow large scale (synoptic) weather patterns. Significant for the Umatilla Tribe is the tendency for upper level winds to travel generally from west to east over the region. Also, during the winter months, northerly wind flows can be associated with storm passages. Given the synoptic weather situation, upper level winds can, on occasion occur from other directions. For air quality-related environmental impact studies, winds from all directions are important; and, therefore, must be considered.

2.2.2 Climatology and Meteorology of the CTUIR Possessory and Usage Rights Area

The climatology and meteorology of the Hanford Reservation is quite well-defined as a consequence of federal research and development activities over an extended period of time beginning in 1945. However, within the proposed CTUIR study area, as shown in Map 3 and Table 2-1, only limited, pertinent detailed information has been compiled on a long-term basis at national weather stations located in Yakima, Washington (approximately 55 miles west of the reference repository site on the Hanford Reservation) and at Pendleton, Oregon (approximately 60 to 70 miles southeast of the Hanford Site and about five miles west of the Umatilla Reservation).

The climate of the local Hanford region is greatly influenced by the surroundig topography. Directly to the west and south of the reference repository location are the Yakima and Rattlesnake Ridges. To the north are the Saddle Mountains and farther to the west the Cascade Range. These topographic features have a significant effect on

Table 2-1. PRINCIPAL LONG-TERM REGIONAL CLIMATOLOGICAL AND METEOROLOGICAL STATIONS

Station	Latitude	Longitude	Elevation	Period of
Hanford Meteorological Station (HMS)	46° 34'N	119° 36'W	733 ft MSL	1912-1980
Yakima, Washington NWS	46° 34'N	120° 32'W	1,052 ft MSL	1943-1982
Pendleton, Oregon NWS	46° 41'N	118° 51'W	1,482 ft MSL	1943-1982

precipitation, winds, and temperatures. The Hanford area is in the rain shadow of the Cascade Range, which contributes significantly to the relatively low rainfall (six to seven inches). The Rocky Mountains and other mountain ranges to the north, northeast, and east in Washington, Idaho, Montano, and British Columbia are effective in protecting the area from the more severe winter storms and low temperatures associated with the modified arctic air masses that move southward through Canada. Occasionally, an outbreak of cold modified arctic or continental polar air will settle over the area, resulting in subzero temperatures in the winter and damaging spring or fall frosts. The location of the Hanford region with respect to topography results ina continental-type climate, since the Cascades to the west generally block the maritime influence of the ocean except through topographic channeling and during synoptic storms. The continental-type climate not only affects precipitation in the region but also results in wide ranges and variations in temperature.

The general surface airflow patterns surrounding the refernce repository location are significantly influenced by the local topography. The prevailing wind near the site is from the northwest to southwest quadrants, but local topographic features and diurnal wind circulations produce a significant degree of variability in winds at other locations in and near the Hanford region. The variation in the wind direction over the region can be explained, to a large-exent, by topographic diverting and channeling effects.

Similar surface airflow patterns are observed at both Yakima, Washington NWS and Pendleton, Oregon NWS. Yakima is located in a small east-west valley in the upper (northwestern) part of the irrigated Yakima Valley. Local topography is complex with a number of minor valleys and ridges giving a local relief as much as 500 feet. Pendleton, Oregon is located in the southeastern part of the Columbia Basin and is also almost entirely surrounded by mountains.

2.2.2.1 Precipitation Precipitation is quite variable throughout the study area. The mean annual precipitation at the Hanford Meteorological Station (HMS) is 6.33 inches. At the Pendleton, Oregon, National Weather Service Station (NWS), the average precipitation is 12.99 inches. In the Blue Mountains, annual precipitation is in excess of 30 inches per year. Most precipitation reaching the area is in the form of cyclonic storms moving in from the Pacific Ocean. These storms have the greatest frequency from April through October. The gradual rise in elevation from the Columbia River to the Blue Mountains creates eastwardly increasing precipitation.

2.2.2.2 Air Temperature, Dew Point, and Humidity The annual (normal) temperature at the HMS site is 11.8°C (53.2°F). From 1912 to 1980 mean annual temperatures have varied from 10.1 to 13.4°C (50.2 to 56.1°F) and have indicated an approximately 20-year monthly temperatures for January and July, the coldest and warmest months of the year are 29.3°F and 76.4°F, respectively. The average daily minimum and maximum temperatures for January are 22°F and 36.9°F, respectively, and for July, 61.2°F and 91.9°F, respectively. The average number of days free of freezing temperatures is 174, with a range between 134 and 215 days.

The annual mean temperature at the Pendleton, Oregon NWS is 52.4°F for the period of observation extending from 1943-1982. The mean monthly temperatures for January and July, the coldest and warmest months of the year, are 32.3°F and 73.3°F, respectively.

The average daily minimum and maximum temperatures for January are 25.2°F and 39.3°F, respectively, and for July, 56.7°F and 89.8°F, respectively.

The annual mean temperature for the Yakima, Washington NWS is 50.7°F for the period of observation extending from 1943-1982. The mean monthly temperatures for January and July are 28.3°F and 70.3°F, respectively. The average daily minimum and maximum termperatures for January are 20.2°F, respectively. The average daily minimum and maximum termperatures for January are 20.2°F and 36.3°F, respectively, and for July, 55.9°F and 88.3°F, respectively.

The annual mean relative humidity at the Hanford Meteorological Station is 54.3%, with the highest relative humidity occurring in December (80.0%0 and the lowest in July (32.2%). The annual mean dew point is 1°C (33°F) and the annual mean wet-bulbl temperature is 6.6°C (43.9°F).

2.2.2.3 Surface Winds The HMS surface wind data were collected from the height of 12.7 meters (41.66 feet) above the ground surface on the 122-meter (400 feet) HMS tower during the period 1945 to 1980. Either west-northwest (WNW) or northwest winds prevail in every month, with June having the highest mean windspeed, 4.1 meters per second (m/s) (10.7 mph) and December having the lowest, 2.7 m/s (8.3 mph). The peak gust in this period of record, 36 m/s (80 mph) was recorded in January 1972.

December has the highest frequency of low wind speeds. Wind speeds in the one to three mph class occur 33% of the time in December compared to 11% in June. The frequency of calms (zero speed for one hour) during December is 7% versus 1% for June. During the period 1949 through 1980, 323 December days had peak winds no greater than 12 mph compared to only six June days. The hourly average wind speeds for June and December indicate that there is much less diurnal range in December than in June. the prevailing direction in December is NW and in June, WNW. There also is a larger diurnal variation in wind from the WNW and NW in June than there is in December at HMS. July has the highest diurnal range of surface wind speeds varying from 5.5 to 12.9 mph. December has the lwoest diurnal range of 5.6 to 6.7 mph. Lower wind speeds (1-3 mph) are predominant in the winter season. The spring season shows a nearly equal distribution of wind speeds for the three class intervals of 4-7 mph, 8-12 mph and, 12-16 mph.

The four stability categories utilized by the Hanford meteorological group at HMS are broadly classified as follows: VS (very stable), MS (moderately stable), N (neutral), and U (unstable), according to the termperature intervals as a function of position on the Hanford Meteorological Tower at 3 feet and 220 feet, respectively, above the ground surface.

The HMS compilations indicate a nearly equal distribution of U (unstable) and MS (moderately stable) stability categories on an annual basis of about 31%. Moderately stable winds prevail in the winter season with a frequency of over 40%. The dominance of unstable winds in both the spring and summer seasons is also evidenced.

In contrast to the relatively good long-term meteorological data available at HMS for the Hanford Site, joint frequency distributions of wind direction, wind speed and wind stability elsewhere in the general region are quite meager. However, joint frequency distributions in the STAR format were developed from National Weather Service station data at Yakima, Washington and Pendleton, Oregon for the year 1976.

The 1976 Yakima, Washington NWS STAR data compilations show prevailing winds from the W and WNW directions with a combined frequency of occurrence of more than 35% irrespective of season. Additionally, wind speeds of 4-6 knots (2.1 - 3.1 m/s) occur with a frequency of over 40% irrespective of season. Moderately stable winds (Pasquill-Gifford Category F) prevailed from 35% to 45% of the time at Yakima, Washington NWS in 1976.

The 1976 Pendleton, Oregon NWS STAR data compilation (annual basis only) demonstrates a prevailing easterly wind direction (about 18% frequency) but sizeable SE, SSE, and S directional components with individual frequencies of approximately 10%. Wind speed frequencies of approximately 37% in the range of 4-6 knots (2.1 - 3.1 m/s) were also dominant on an annual basis at Pendleton NWS for the year 1976. Moderately stable winds (PG category F) occur with an annual frequency of nearly 35%.

2.2.2.4 Upper Level Winds As previously mentioned, winds above the surface are not as influenced by terrain and tend to be more consistent in direction. Also, winds in the mid-latitudes tend to increase with height above the surface up to the stratosphere (approximately 12 kilometers).

Upper wind measurements are very important to the concerns of the Umatilla Tribe, since these data reflect the potential for long range transport of atmospheric releases on the Hanford site to the CTUIR possessory and usage rights area. Unfortunately, very little data exist on or near the CTUIR study area for upper wind parameters. The National Weather Service (NWS) maintains upper air monitoring sites at Spokane and Boise. At these sites two balloon soundings are taken per day, one at 0000Z (12:00 midnight Greenwich time). Continuous wind data are not available for the area.

The limited available data indicates that surface influences on wind extend up to at least 900 millibars (mb) (400 ft. above surface for Boise and 900 ft. above surface for Spokane). However, some gradual turning of the wind at the 900 mb level indicates that upper air influences start to be reflected and that the changes in wind speed and direction from the surface to the upper atmosphere are continuous and gradual.

2.2.2.5 Atmospheric Dispersion Characteristics. The ultimate transport and accumulation of atmospheric contaminants is not only dependent on wind but importantly, on the atmospheric vertical and horizontal distributions of temperature. A number of different, but related, parameters including stability, mixing height and inversion height, measure these critical temperature-related characteristics of the atmosphere's ability to disperse any contaminants.

Stability measurements are very limited in the general CTUIR study area. Available data for Pendleton and Spokane are shown in Table 2-2 using the conventional classification scheme devised by Pasquill-Gifford (1961) whereby stable and neutral

conditions generally indicate poor dispersion characteristics and unstable conditions represent more favorable regimes for dispersion. Table 2-2 illustrates that the Pendleton area exhibits much more stable and neutral conditons. Importantly, though, more stable atmospheric conditions exist than unstable conditions for both locations. The tendency for the area is to have poor dispersion characteristics.

Mixing height is a measure of the depth from the surface to the point in the atmosphere where vigorous vertical mixing of air parcels occurs. The inversion height is a measure of the vertical depth of an inversion layer. Inversion is that condition where the temperature of the atmosphere rises with elevation (a negative lapse rate) causing stable atmospheric rises with elevation (a negative lapse rate) causing stable atmospheric conditions. Although there are differences in how mixing and inversion heights are calculated, they can essentially be considered to be similar measures of the vertical depth of stable atmospheric conditions. These measures indicate the volume of air in which dispersion (or nondispersion) can take place; e.g., the smaller the inversion depth the smaller the volume for dispersion and the higher the pollutant concentrations. Also these measures indicate the potential relationship between surface and upper air flow regimes.

Very limited data exists in the CTUIR study area on mixing height or inversion height characteristics. Holzworth (1972) has calculated mixing depths for various locations using data collected by the National Weather Service. On the basis of the Holzworth data, the average annual morning mixing height in the CTUIR study area should exhibit a range of 300 to 400 meters with afternoon mixing heights rising to approximately 1600 meters.

2.3. Hydrology

As presented in the CTUIR Scoping Study (CERT, 1984), the protection of water resources is a very important concern of the Umatilla tribe. The maintenance of clean rivers and streams for domestic, irrigation, fishing, recreation and other uses within the reservation as well as the study area is a priority of the tribe. The following sections present a brief overview of the surface and ground water resources of the study area. In

Table 2-2. ANNUAL ATMOSPHERIC STABILITY ARRAY (STAR) FOR SPOKANE, WASHINGTON AND PENDLETON, OREGON

Location	Frequency of Stability Occurrence (Percent)*					
	A	B	C	D	E	F
Spokane[a]	0.3	4.1	10.7	57.1	14.3	13.6
Pendleton[b]	0.3	7.0	12.1	23.5	25.5	31.6

[a] CERT, 1984
[b] CERT, 1984 b

*Stability Classification	Pasquill-Gifford Category
Extremely Unstable	A
Moderately Unstable	B
Slightly Unstable	C
Neutral	D
Slightly Stable	E
Moderately Stable	F

general, the following sections are summaries of the information presented in the Scoping Study, with some material updated to reflect the studies completed in the past two years.

2.3.1. Surface Water

The following delineates the surface water hydrology of the CTUIR study area. Surface water is discussed in terms of both water quality and quantity.

2.3.1.1 Surface Water Quantity The CTUIR study area encompasses approximately 10,000 square miles of the Columbia River drainage basin in the western part of Washington and Oregon. Major rivers and streams within the study area include the Columbia, Yakima, Snake, Walla Walla, Grande Ronde, John Day, Powder, Burnt, Umatilla Rivers and Willow Creek. The drainage basins for these rivers are presented in Figure 2-2. Drainage characteristics of the major rivers within the CTUIR study area may be described as follows:

COLUMBIA RIVER. The Columbia River is one of the major rivers in the world. Having a total drainage area of over 260,000 square miles and an annual discharge twice that of the Nile River, the Columbia River originates in Canada and flows to the Pacific Ocean forming the boundary between the states of Oregon and Washington (see Figure 2-4). The topography of the Columbia River drainage basin is very diverse; ranging from high, rugged mountains to the Palouse Plains. Numerous dams regulate the flow of the Columbia River, and many are controlled by the U.S. Army Corps of Engineers.

The Columbia River is very important to the Umatilla Indians. Having fishing rights which extend from the Priest Rapids Dams, north of Richland, to the Bonneville Dam just east of Portland, the Columbia River plays an important role in the lives of the Umatilla Tribe. The average flow of the Columbia River at the McNary Dam is 182,000 cfs with high flows occurring during the months of April, May, and June, and low flows during the months of August, September, October, and November.

SNAKE RIVER. The Snake River is the largest tributary of the Columbia River System. Having a total drainage area of 109,000 square miles, the Snake River extends from

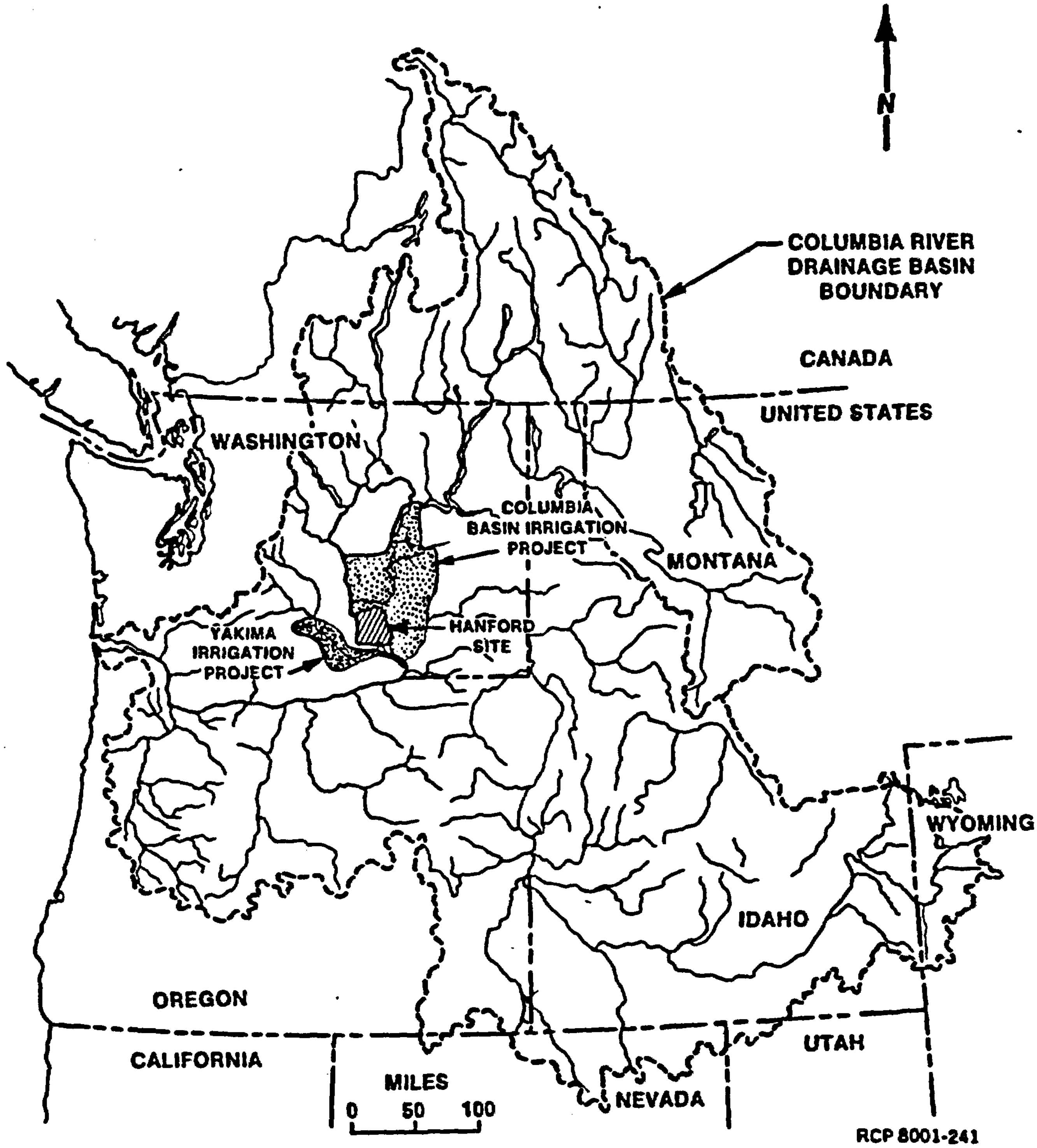


Figure 2-4. THE COLUMBIA RIVER DRAINAGE BASIN

northwestern Wyoming to just south of Pasco, Washington. The topography with the Snake River Basin ranges from the rugged mountain ranges of the Bitterroot and Teton Mountains to the rolling Snake and Palouse Plains. Average annual dischare of the Snake River below Hells Canyon Dam on the Idaho-Oregon border is approximately 16 million acre-feet with an outflow at the Ice Harbor Dam (just east of its confluence with he Columbia River) of 41 million acre-feet. Low flows generally occur during the months of April, May, and June, with high flows occurring during the months of August, September, and October.

<u>YAKIMA RIVER</u>. The Yakima drains only a small portion of the study area and will not be discussed here.

<u>UMATILLA RIVER AND WILLOW CREEK</u>. The northwestern part of the study area is drained by the Umatilla River and Willow Creek. The Umatilla River has a drainage area of about 2,700 square miles and Willow Creek has a drainage area of approximately 850 square miles. The sources of these drainages occur in the Blue Mountains with discharges into the Columbia River. Some of the larger tributaries of the Umatilla River include Meacham, McKay, Birch, Wildhorse, and Butter Creeks.

The Umatilla River and its tributaries are extremely important to the Umatilla Indians. Within the reservation the tribe is responsible for allocating water rights and maintaining the fishery. The tribe is presently working with the Bonnevile Power Authority, the Bureau of Reclamation and various irrigation districts to improve fish access and habitat in the lower Umatilla Basin. Flow records at Pendleton, Oregon show that the average daily discharge of the Umatilla River at Pendleton is 502 cubic per sencond. The average daily discharge for Willow Creek is approximately 32 cubic feet per second. Low flows for both systems occur during the months of August, September, and October, while high flows occur in the months of February, March, April, and May. The highest flow recorded on the Umatilla River was 15,500 cfs in January of 1965.

<u>WALLA WALLA RIVER</u>. The Walla Walla Basin of northeastern Oregon and southeastern Washington is roughly triangular in shape. Encompassing a drainage area of about 1,330 square miles, the Walla Walla River heads in the Blue Mountains and discharges into the Columbia River just south of the Tri-Cities. The South Fork is the principal tributary. Other major tributaries of the Walla Walla River include the Touchet River and Mill Creek. The average daily discharge of the Walla Walla River at Touchet, Washington is

589 cfs. High flows generally occur during the months of January, February, and March with low flow occurring in the months of July, August, September, and October.

UPPER GRANDE RONDE RIVER. The Upper Grande Ronde River Basin of northeastern Oregon encompasses some 1,400 square miles and is bounded on the west by the Blue Mountains and on the east by the Wallowa Mountains. The topography of the basin includes both valley plains and mountainous upland. The river flows northeast to the Snake River about 25 miles above Clarkston, Washington. Average daily flow of the Grande Ronde near Troy, Oregon is 3,132 cfs, with high flows occurring during the months of February, March, May and June. Low flows occur in August and September.

POWDER-BURNT RIVERS. The Powder and Burnt Rivers lie in the southeastern portion of the study area. The combined drainage basin encompasses approximately 3,240 square miles. Both rivers joint the Snake River above Brownlee Dam. The average daily flow near Richland, Oregon for the Powder River is 266 cfs and the average daily flow near Hereford, Oregon on the Burnt River is 86 cfs. High flows occur during the months of February, March, May and June with low flows occurring in August and September.

JOHN DAY RIVER. The John Day River Basin, located in northcentral Oregon, has an area of approximately 8,010 square miles. The John Day River originates in the Blue Mountains southeast of Prairie City and flows into the Columbia River near John Day Dam. Major tributaries include: the North and South Forks, Canyon, Bridge, Pine, Butte, Thirtymile and Rock Creeks. The average daily discharge of the North Fork at Monument, Oregon is 1,250 cfs and for the main stem at McDonald Ferry, Oregon is 2,064 cfs. High flows occur during the months of February, March, May and June with low flows occurring in August and September.

2.3.1.2 Surface Water Quality The chemical quality of the surface waters within the study area is dependent on the geology over which the water flows. Sedimentation and pollution caused by man also contribute to the deterioration of the surface water quality. In general, the surface water quality of the Umatilla Reservation and study area is quite good and satisfactory for most purposes. Water quality of the Umatilla River is soft and generally contains less than 120 mg/l of total dissolved solids. Other rivers in the ara also are considered slightly mineralized.

One of the biggest concerns of the Umatilla tribe is pollution caused by various agricultural practices. Suspended sediment generated by the erosion of the rolling Palouse plains contribute tons of sediment into recieving streams every year. Feed lots are also a problem due to livestock-generated organic contaminants. Steams which were contaminated in the past are slowly being restored by the tribe so that a healthy fish population can be established.

2.3.1.3 Surface Water Availability The surface water resources of the CTUIR study area are extremely important to the Umatilla Indian people. Historically, most of the surface water supplies have been developed for agricultural, municipal and industrial uses. The Bureau of Reclamation is currently developing a Umatilla River Project Plan. The ultimate goal of this plan is to obtain data which would aid in water resource planning in the basin.

2.3.2 Ground Water

Ground water plays an important role in terms of an available water supply for the Umatilla Tribe. The following provides an overview of the ground water hydrology of the CTUIR study area.

Each stratigraphic unit described in the geology section (Section 2.1) acts as a water-bearing unit within the study area. These units include the metasedimentary, igneous and volcanic rocks of the basement complex; the basalt flows and sedimentary interbeds of the Columbia River Plateau; and the unconsolidated alluvial deposits along drainages. The water bearing characteristics of these units are described as follows:

BASEMENT COMPLEX AQUIFERS: The basement complex in the study area consists of the metamorphic rocks which were intruded by granite-like intrusives and other pre-Tertiary volcanic rock units. These units are essentially crystalline and lie deep below other sources of ground water. Ground water movement in these units is along fractures and within fault and weathered zones. Few wells are completed in the crystalline rock units within the study area.

COLUMBIA RIVER BASALT: The Columbia River Basalts of Tertiary age are the most important source of ground water in the study area. Underlying approximately 55,000

square miles of Washington, Idaho, and Oregon, these aquifers are extremely important sources of ground water for many communities in the area. In addition, these aquifer zones will be the most affected by the potential placement of the high-level nuclear waste repository at Hanford.

In the study area, these basalts have the same hydrogeologic characteristics as the Columbia River Basalts throughout the region. Ground water occurs mostly in (1) the upper, characteristically broken parts of the basalt flows; (2) the sedimentary material between flow; and (3) the basal vesicular portions of the flows. The flow centers consist of jointed and massive basalt which, except where fractured, have a relatively low water bearing capacity.

The recharge and discharge characteristics of the basalt aquifers are quite variable. Recharge to aquifers occurs along fractures, tension cracks and outcrops along limbs of anticlines and synclines. Recharge can also occur along rivers if the dip of the basalt flow is greater than the gradient of the stream. Discharge of the basalt aquifers may be due to pumping, seepage from surface springs and seeps, or subsurface flow into alluvium along present stream courses.

ALLUVIAL AQUIDERS: Alluvium in the study area consists of a variety of sediments, ranging from gravel to fine grained silt and clay. The sand and gravel are usually lenticular and are of limited extent. Wells developed in the alluvium are of low capacity, and yields are dependent on the stage of the nearby river or stream. The alluvium is not considered a major aquifer in the study area.

2.3.2.1 Ground Water Quality The ground water in the study area is generally excellent for most uses. The water is low in mineral content, soft to moderately hard, and free of undesirable concentrations of detrimental elements. The types of ground water vary among the various geologic units with bicarbonate usually being the major anion and calcium and magnesium the major cations. High concentrations of sodium may be present in some aquifers.

2.3.2.2 Ground Water Availability For the most part, ground water is available to wells within the study area for domestic, irrigation, municipal and industrial use. Although the Columbia River Basalt is the most important aquifer, the crystalline rocks are capable of sypplying limited quantities of water (5 to 20 gpm), depending on the degree of

fracturing. Hydrogeologic basins are perhaps the best long-term sources of ground water, although, over withdrawal could cause the depletion of these valuable sources of ground water.

2.4 SOILS

Soil provides the medium for the growth of both cultivated crops and native roots, berries, and herbs used by the tribe for both food and ceremonies. Soil also provides a major contaminant of the surface water system throughout the study area due to erosion of clearcut forest and plowed cropland. For both these reasons, the development of a baseline for the soils found throughout the study area is important to the tribe.

2.4.1 Origin of Soils

Soil is the product of the forces of weathering and erosion acting on natural geologic materials. The soils of the study area have a wide range of characteristics, depending on such factors as the:

(1) Physical and mineralogical composition of the parent material;

(2) Relief and topography, which strongly influence drainage, runoff, erosion, and exposure to sun and wind;

(3) Climate, especially precipitation and temperature, under which the soil material has accumulated and existed since forming;

(4) Vegetation and animal life which exists in and on the land; and

(5) Length of time that forces of soil formation have acted on the soil material.

The soils of the study area, therefore, range from fertile, deep, dark-colored soils of the river valleys to thin, non-arable soils with a large proportion of exposed bedrock on the steeper mountain slopes. These soils also support a wide range of native vegetation,

from sagebrush in the drier areas to lodgepole pine and Douglas fir at higher elevations in the mountains.

2.4.2 Soil Associations

Soil scientists use the term "soil series" to describe soils that have similar compositions, thicknesses, and horizon arrangement. When two or more soil series are associated geographically or by use in a manner which makes separation impractical, they are grouped into a "soil association." The associations in the study area, based on parent material, include:

(1) Alluvium—very deep, nearly level, somewhat poorly drained, silt loan soils formed inalluvium on valley floors;

(2) Loess—very deep, gently sloping to moderately steep, moderately well drained to well drained, silt loam soils that formed in loess on uplands;

(3) Basalt—deep to very deep, gently sloping to steep, well drained soils formed in material derived from basalt on plateaus;

(4) Ash and tuff—shallow to deep, moderately steep to very steep, well drained, silt loam to gravelly silt loam soils that formed in colluvium derived from volcanic ash, tuff, and loess;

(5) Granite—deep to very deep, very steep, well drained, silt loam to gravelly silt loam oils formed in volcanic ash, loess, and granitic residuum on mountain sides;

(6) Sedimentary rocks—moderately deep to very deep, very steep, well drained silt loam to gravelly silt loam soils formed in shale, quartzite, and other sedimentary and metamorphic rocks on canyon walls and mountain sides;

(7) Rough, broken, and stony land—land too steep or with bedrock too near the surface to have formed a soil.

2.4.3 Soil Erosion

Some soil erosion from the actions of water and wind is inevitable. Erosion only becomes a problem when the rate of erosion exceeds the rate at which new soil can be created. On farmland in the study area, a maximum erosion rate of 5 tons per acre per year has been considered acceptable because this is the rate at which the soil is replaced through natural processes.

Erosion due to water can be in the form of "sheet," "rill," or "gully" erosion. Sheet erosion is the removal of a thin, relatively uniform layer or soil by the direct action of raindrops and moving sheets of runoff water. Rill erosion is the formation of many narrow, shallow channels through the collection of runoff into small streams. When the rills begin coalescing into larger channels, the runoff erodes wider an deeper channels called gullies.

The primary locations of severe erosion in the study areas are the highly cultivated plains and prairies underlain by highly erodible, wind-blown silt, or "loess." These areas average an erosion rate nearly double the acceptable level. Pasture and range areas generally average one-fourth the acceptable level while forested areas which have not been clear cut by logging average only one-sixth the acceptable level. Clear cutting may temporarily raise this rate to more than twice the acceptable level and cause some permanent damage due to the generally steep slopes on forested land, but revegetation can reduce the impact after several years.

2.5 VEGETATION

Vegetation, both native and cultimated, provides a significant portion of the diet of teh tribe. Native vegetation, such as roots, berries, bark, and moss is not only used by the tribe for food and cermonial purposes, but is also eaten by both domesticated and wild animals that are, in turn, used as food by the tribe. Crops, such as wheat, peas, and barley are generally not eaten locally, but are exported to other areas. Local crops of vegetables, corn, and fruit are, however, eaten by the tribe and should be studied as part of the baseline environment.

2.5.1 Vegetation Characteristics

The CTUIR study area exhibits great diversity in climate, soils, geology, topography, and extent of disturbance of man and by fire. A highly complex pattern of natural and cultivated vegetation has resulted from this diversity. The native vegetation of the study area falls into three major factors, but dominated by elevation and precipitation. Shrub/steppe vegetation, such as sagebrush and grass, dominates the vast rolling hills of the Palouse loess-covered plans and prairies of the Columbia Basin, which is also the most intensively cultivated part of the study area. Forest vegetation, primarily conifers, predominates in the moderate to high elevation portions of the Blue Mountains.

2.5.2 Plant Communities and Succession

The native vegetation of the study area can be best described as a series of plant communities that are elevation, and therefore, temperature and rainfall dependent, rather than as individual plant species. These communities, or groups of plants living in close prosimity in similar topographic and climatic conditions, are as follows:

SHRUB/STEPPE. The shrub/steppe region is characterized by sagebrush and rabbitbrush with some areas of exposed soil in the drier areas. In somewhat moister areas, the region is dominated by native wheatgrass, bunchgrass, annual forbes, and perennial shrubs. When this native vegetation is destroyed by plowing or grazing, it may be succeeded by noxious weeds, such as Canadian thistle, bindweed (wild morning-glory), and prickly pear cactus. In moister areas, the succession may include annual grasses and forbs, such as fescue, arrowhead balsamroot, and lupine, and, along streams and irrigation ditches, by Russian olive and cedar.

FOREST. The variety of trees dominating the forest portions of the study area are very elevation dependent, although all the forests are dominated by conifers. Dense, mature forests have multiple layers including tall conifers, sparse understory shrubs, and a ground layer of broad-leafed forbs and herbs. Where disturbance has removed the overstory trees, dense herbaceous and shrub layers with deciduous trees, such as aspen, western larch, and Sitka alder, and seedling conifers, such as lodgepole pine, are typical succession plants. The following elevations are merely general guidelines and considerable overlap is to be expected due to variations in soil depth, available moisture, and exposure to sun and wind:

1,500 to 2,500 feet. The lower elevation forest is dominated by the ponderosa pine and, as available moisture increass, Douglas fir. The understory consists of such shrubs as bitterbrush, snowberry, chokecherry, ninebark, and mountain maple and such grasses as wheatgrass, fescue, and bluegrass.

2,500 to 4,000 feet. The middle elevation forest is dominated by western red cedar on moister, north-facing slopes and by grand fir on the drier south-facing slopes and ridgetops. Other trees found in lesser numbers at this elevation include the western larch and western white pine, as well as the ponderosa pine and Douglas fir found at lower elevations. The understory consists of such shrubs as thimbleberry, snowberry, rose, and huckleberry and forbs such as clintonia and violet. Grass is sparse at this elevation.

4,000 to 5,500 feet. The high elevation forest consists primarily of Englemann spruce, subalpine fir, and lodgepole pine. Secondary trees include subalpine larch, mountain hemlock, and scattered stands of lower elevation conifers. Understory shrubs consist of huckleberry and beargrass below lodgepole pines and rusty menziesia, myrtle pachistima, and pinegrass in other areas. Oregon boxwood is found in some disturbed areas.

2.5.3 Threatened and Endangered Species

There are apparently few threatened and endangered species in the study area. No species appearing on the Federal threatened plant species list were located within the study are. The only plant on the list of endangered plant species that occurs in the study area is the MacFarlane's Four O'Clock (Mirabilis Macfarlanei). This plant is found on the grassland prairies of Wallowa County, Oregon and Idaho County, Idaho. These prairies have been subjected to extensive cultivation and grazing, which may potentially threaten other native species in the future.

2.5.4 Cultivated Crops

Nonirrigated cropland in the study area is used primarily for wheat, barley, oats, peas, hay, and pasture. The area underlain by the Palouse loess is the most productive wheat-

growing cropland in the Northwest. The addition of sprinkler irrigation to much of the study area has dramatically increased the already high crop production. Wheat yields average 25 to 80 bushels per acre and barley averages 25 to 85 bushels per acres. Under sprinkler irrigation, wheat production increases substantially, rising to an average of 50 to 120 bushels per acre. Nonirrigated grass hay production averages 1 to 3 tons per acre, while irrigated alfalfa hay production averages 4 to 7 tons per acre.

Non-grain crops produced in the study area include irrigated fruit, peas, and potatoes. The orchards of the Walla Walla valley, in the northern part of the study area are famous for their apples, cherries, plums, and prunes. A recently instituted fruit crop in the area is the production of wine grapes on large vineyards in the Palouse loess. Peas have been produced commercially in the area since 1931 and a cannery was opened in Pendleton in the late 1940's. Potatoes are gown in both the irrigated areas and in the mountain valleys, generally for the Northwest market.

2.6 Fish and Wildlife

The use of the fish and wildlife resources of the CTUIR study area by the tribe began long before the establishment of the reservation or the creation of the state of Oregon. The survival of some members of the tribe to this day depend on the conservation of this resource for the use of future generations of tribal members. For this reason, the importance of fish and wildlife rivals the importance of the rivers and streams in the continuing survival of the tribe.

2.6.1 Fishery

The mainstem Columbia River, the Umatilla River, and their numerous tributaries provide habitat for both resident and anadromous fish important to the tribe. The resident fish include native sturgeon in the Columbia and Snake Rivers and stocked trout in Indian Lake. The anadromous (species that spawn in fresh water, migrating to the ocean to mature) fish include the salmon and steelhead in the Columbia, Umatilla, Grande Ronde, John Day and other rivers of the study area. For more detailed information, refer to the CTUIR High-Level Nuclear Waste Scoping Study (CERT, 1984).

2.6.1.1. Fishery Regulation Subsistence, ceremonial, and commercial fishing are subject to the CTUIR Fish and Wildlife Code, both on the reservation and in the "usual and accustomed places" off the reservation. Subsistence fishing is open all year for tribal members unles sthe Fish and Wildlife Committee sets a specific season. Tribal members can engage in ceremonial fishing only during the periods designated for that ceremony. Commercial fishing is allowed only outside the reservation boundaries in accordance with the rules of both the CTUIR and the Columbia River Intertribal Fish Commission. Most of the commercial fishing involves either the anadromous fish or sturgeon. For example, set gill net fishing is allowed during the salmon runs in Fishing Treaty Zone No. 6 on the mainstem of the Columbia, between Bonneville and McNary Dams. Trout fishing in the streams and lakes of the reservation is open to non-Indians from May to December. Sturgeon fishing is allowed on the Columbia only during a short period during May.

2.6.1.2 Anadromous Fishery Because the importance of the anadromous fishery to the tribe cannot be overemphasized, the anadromous fishery is discussed in more detail in this section. Since part of the salmon and steelhead runs occur in the mainstem of the Columbia, which flows through Hanford before entering Zone 6, there is a high potential for environmental damage to the fishery. To better follow the discussion, refer to the drainage basin map (Figure 2-2).

The Umatilla River has historically supported runs of spring and fall chinook salmon, coho salmon, and steelhead. Currently, summer steelhead is the only anadromous fish known to inhabit this river in significant numbers, with 700 to 3000 adults returning each year to spawn. This wide variation in returning adults is thought to be a function of summer streamflow conditions. Most of the spawning and rearing takes place in the upper tributaries of the mainstem of the Umatilla, making the mainstem a critical migration route.

The largest remaining stock of native anadromous fish in eastern Oregon is found in the John Day River and its tributaries. Although spring chinook spawn in the John Day mainstem and parts of the Middle Fork, most of spawning occurs in the North Fork, just south of the CTUIR. Current spawning estimates are 3500 spring chinook, 1000 fall chinook, and 15,000 summer steelhead adults. These results, however, indicate a downward trend for both spring chinook and summer steelhead. Increases in water temperature and compacting of the spawning gravels due to soil erosion and sedimentation have contributed to this decline.

Spring and summer chinook and steelhead and remnant populations of fall chinook and coho are widely distributed in the Grande Ronde river basin. Annual counts indicate a downward trend in spring chinook and summer steelhead, and irrigation developments have eliminated sockeye salmon.

The Imnaha River runs have declined since the 1970 count of 4440 spring chinook, 2200 summer chinook, and 3000 steelhead. The spawning habitats in the basin are, however, considered to be good to excellent compared to the Umatilla, John Day, and Grande Ronde.

The Pasco, Walla Walla, Powder-Burnt, and Malheur rivers also occur in the study area. Some of these rivers, such as the Tucannan, a tributary of the Walla Walla, are still fished by the tribe but only on a very minor scale. Others, such as the Malheur and Powder-Burnt, have had all anadromous fish extirpated as a result of a series of dams onthe mainstem of the Snake River.

2.6.2 Wildlife

The CTUIR study area supports a wide variety of mammals, birds, reptiles, and amphibians. More detailed information on the wildlife may be found in the CTUIR High-Level Nuclear Waste Scoping Study (1984).

The CTUIR study area contains an abundance of game animals, including big game, furbearers, upland game birds and mammals, and waterfowl. Abundant non-game mammals, birds, reptiles, and amphibians are also found in the area. Due to the importance of hunting and trapping to the tribe, however, only game and threatened and endangered species are discussed in this section.

2.6.2.1 Game Animals According to the tribe's Fish and Wildlife Code, tribal members are entitled to hunt and trap during open seasons throughout the traditional possessory and usage rights area. Special subsistence and ceremonial hunting may also be permited by the Fish and Wildlife Committee during closed seasons. Non-Indians are limited to pheasant, quail, and partridge hunting on the reservation.

The major big game species in the study area include deer, elk, pronghorn antelope, bighorn sheep, mountain goat, black bear, and mountain lion. Two species of deer, mule and white-tailed, are found in the area, with mule deer range occupying nearly 90 percent of the region. Rocky Mountain elk range covers nearly 50 percent of the area and includes both summer and winter range. Bighorn sheep occur in the Lostine River Canyon and have been transplanted into the Wenaha and Snake River (Hells) Canyons. The mountain goat is also a transplant, having been reintroduced into the Elk Horn Wildlife Management Area and the Eagle Cap Wilderness Area. The large carnivores generally occupy the higher, forested portions of the Blue Mountains and the deep canyons along the Oregon-Idaho border.

The furbearers are defined in the CTUIR Fish and Wildlife Code as beaver, muskrat, coyote, bobcat, raccoon, marten, and mink. The beaver, muskrat, and mink occupy the riparian areas throughout the study area, while the raccoon prefers middle elevation, hardwood riparian zones. The marten and bobcat occur in the higher coniferous forests, with the latter species greatly reduced in recent years due to over trapping. The coyote is protected by the tribe due to its cultural significant and is hunted only half the year.

Upland game birds found in the study area and included in the tribal Code include the mourning dove, wild (Merriam's) turkey, blue grouse, ruffed grouse, sage rouse, gray (Hungarian) partridge, California quail, mountain quail, chukar, and ring-necked pheasant. Upland game mammals include the cottontail and pigmy rabbits, the black-tailed jack rabbit, and the snowshoe hare. The range of these species varies from populated wheat fields for the pheasant and gray partridge to riparian woodlands for the morning dove and wild turkey to mountainous coniferous forests for the ruffed grouse and mountain quail.

Portions of the study area serve various species as wintering areas, migration rest stops, and summer breeding areas for waterfowl and shorebirds. The species defined in the tribe's Fish and Wildlife Code include the Canada, white-fronted, and snow geese, the mallard, gadwall, pintail, American widgeon, shoveler, wood duck, redhead, canvasback, Barrow's goldeneye, bufflehead, ruddy, and ring-necked ducks, and the green-winged, blue-winged, and cinnamon teal. Also included are the common, red-breasted, and hooded mergansers, the lesser scaup, the American coot, and the common snipe.

2.6.2.2 Threatened and Endangered Species Six species of endangered wildlife occur within the study area as either permanent residents or an migratory transients. Seven additional species are found on either the state or federal threatened species list. The endangered resident species include two birds, the peregrine falcon (Arctic, Peale's, and American subspecies) and the upland sandpiper. Four migratory birds, the Aleutian Canada goose, the white pelican, the sandhill crane, and the snowy plover, that are endangered pass through the state during semi-annual migrations.

Three resident bird species, two mammals, a reptile, and an amphibian listed as threatended are found within the study area. The birds include the bald eagle, ferruginous hawk, and spotted owl. The mammals are the pygmy rabbit, found in semi-arid sage and rabbitbrush habitats, and the wolverine, found in the higher portions of the Blue Mountains. The western pond turtle and the western spotted frog are still found in western portions of Washington and Oregon, but have been nearly or completely exterminated in the eastern parts of the two states.

3.0 ENVIRONMENTAL MONITORING PLAN - BASELINE REQUIREMENTS

3.1 MONITORING PROGRAM DESIGN

The design of the CTUIR environmental monitoring program is based upon the preliminary characterization of potential contaminant release scenarios. These scenarios are of prime importance in the development of tribal risk assessment methodologies to assess possible health, safety, and environmental impacts as a consequence of the construction, operation, and long-term storage of high-level nuclear waste in an underground geologic repository at the Hanford Site, Washington (CERT, 1986). The environmental monitoring program is primarily intended to provide baseline information on existing background levels of selected radioactive and non-radioactive constituents in the CTUIR possessory and usage rights area as previously stated in Section 1.0 and as illustrated in Maps 1 through 4. As earlier inferred in Section 2.0 of this plan, this area presently includes the Umatilla Reservation and its ceded lands. The parameters to be measured are based on the existing natural environment and the composition of the high-level nuclear waste. If a contaminant release scenario were to occur, the monitoring program would be used to measure and evaluate any change in pollutant levels from the resultant release.

3.1.1 Atmospheric Monitoring Program

Both the physical and chemical characteristics and quantities of specific pollutants (or combinations of pollutants) which can become airborne as atmospheric emissions are dependent on the particular category of release scenario. For example, airborne radioactive materials can become an important direct exposure pathway to people if those materials are breathed into the body or if a direct external radiation exposure is received from an airborne cloud of radioactive materials (even if the radioactive materials are not inhaled).

If the pollutants in the airborne emissions fall on the ground, on plants, or in water, contamination of the soil, plants or water can occur. If such contamination does occur,

Broadbased national and/or regional networks are used to evaluate such parameters as worldwide fallout or acid rainfall. These networks are frequently multi-state, operate for long periods of time (years), and they are commonly used to document background levels, to show historical trends, to evaluate short term excursions, to determine the general quality of some particular short-term excursions, and to determine the general quality of some particular aspect (e.g., air quality, water quality, radiological) of the environment. Sampling locations in broadbased networks are frequently selected to be representative of numbers of people (usually large communities or perhaps large milksheds or watersheds). As an example, the U.S. Environmental Protection Agency's implementation of the Safe Drinking Water Act and the Interstate Quarantine Regulation (Public Health Service Drinking Water Standards) requires monitoring of major drinking water supply systems on a routine basis for both radiological and non-radiological parameters. The latter network alone monitors about 700 water supplies serving over half the U.S. population with access to public water supplies.

Available information on some of the more pertinent monitoring networks which have sampling stations in the states of Idaho, Oregon, or Washington are summarized in Appendix A. The state of Idaho does not operate an environmental radiological monitoring program of its own. The USEPA has a standby network of air and milk sampling stations operated by its Office of Research and Development using USDOE funding from the Nevada Operations Office. This network is normally in a standby mode and is activated to sample whenever radioactive fallout is anticipated. The fallout can originate from either foreign or domestic programs. The network was most recently activated to sample for airborne debris from the Chernobyl disaster. A second, more comprehensive program is operated on a continuous basis by USEPA's Office of Radiation Programs. It is designated the Environmental Radiation Ambient Monitoring System (ERAMS).

3.1.1.2 Definition of Parameters for Tribal Environmental Baseline Monitoring Program. Meteorological, climatological, and radiological parameters require detailed definitions to appropriately develop the tribal environmental baseline monitoring program for the subsequent environmental assessment of potential airborne contaminants.

internal radiation exposure can be received by humans or animals eating contaminated vegetation or drinking contaminated water. Direct external radiation exposure can also be received from being near the deposited radioactive materials.

Monitoring of airborne emissions can be done by several methods. It usually takes the form of an indirect measurement in that a sample of air is collected in the field at the sampling site and removed to a laboratory for analysis. One common method is to pull air through a filter, thereby removing any airborne radioactive particulates. The filter can then be taken to the laboratory for analysis. If the radioactivity in the air is present in a gaseous form (such as krypton-85), the sample may consist of a whole air sample collected as a compressed gas or as a sample pumped into a plastic bag. If the radioactivity is contained in the water vapor in the air (i.e., radioactive tritium), the water vapor can be collected by a freeze sampler or by filtering through some medium such as silica gel or a molecular sieve. All of these samples are normally taken to a laboratory for analysis. The analytical method can range from simple and inexpensive to sophisticated and very expensive, depending on the radionuclide being measured.

3.1.1.1 Existing Monitoring Programs Presently, there are in operation in the states of Idaho, Oregon, and Washington, several state or federally funded programs to measure on a continuing basis various radiological and non-radiological parameters which can be used to evaluate environmental quality. Most of these programs do not have sampling stations located close enough to reservation or ceded lands to be readily useful to the CTUIR High Level Nuclear Waste Study Programs.

Most monitoring programs are source-oriented and usually consist of sampling networks designed to provide information for a particular facility or to address a specific problem. The state of Washington, for example, has several sampling networks designed to monitor such facilities as the Trojan and Washington Public Power Supply System Nuclear Power Plants, three uranium mills, the U.S. Ecology commercial low level radioactive waste burial site, and the Hanford site. Typically, such networks consist of an intensive grid of sampling or monitoring stations close to the individual facility with a much smaller number of stations much further away from the facility. Other source-oriented networks may be set up to measure non-radiological air quality at such facilities as smelters or fossil fuel power plants. Source-oriented networks typically cover a relatively small area, can operate for either short or long periods of time, and are usually used to determine compliance with standards or to crosscheck facility operators monitoring programs.

Meteorological and Climatological Parameters.

In order to obtain baseline data for an impact assessment of potential atmospheric emissions of both radioactive and non-radioactive materials, a number of meteorological and climatological parameters must be routinely monitored on a continuous basis. These measured parameters should include—but not necessarily be limited to—ambient temperature, ambient pressure, surface wind direction, speed and stability, relative humidity (dew point), and precipitation (both rainfall and snowfall).

The foregoing meteorological and climatological baseline parametric data will be collected at either a permanent station and/or a portable, mobile laboratory at pre-selected monitoring sites within the proposed CTUIR study area. In either case, the aforementioned, continuously monitored parameters will be recorded and compiled on a computer-based, multi-channel data acquisition system (DAS) for statistical analysis at a pre-designated on-reservation tribal facility.

As previously outlined in Section 1.0 of this plan, the establishment of a continuous, long-term baseline meteorological and climatological monitoring system at specific location(s) in the immediate CTUIR study area will provide the tribe with the necessary baseline data essential for the preparation of a tribal impacts assessments prior to the issuance of a DOE environmental impact statement (EIS) for a permanent high-level nuclear waste repository at the proposed Hanford Site, Washington. In addition, the tribal meteorological and climatological baseline compilations are necessary to provide essential input data for predictive mathematical modeling of specific airborne contaminant release scenarios. Capability for determining the most probable airborne contaminant plume trajectories, dispersion characteristics, downwind transport, and possible deposition at the ground-level surface are all essential to the assessment of health, safety, and environmental impacts within the proposed CTUIR study area.

No upper wind measurements are planned for the first year of the tribal baseline environmental monitoring program. While such measurements are desirable, they are not proposed at this time. Should upper wind data be required for the atmospheric dispersion modeling analysis of specific release scenarios, the existing long-term upper wind data bases derived from the National Weather Service (NWS) stations identified in Map 3 and located at Boise, Idaho; Seattle, Washington; and Spokane, Washington, will be utilized. Additionally, the long-term upper wind data compilations collected on the Hanford

Reservation (CERT 1985) and also identified in Map 3 would be employed for such analyses.

Radiological Parameters.

Although several non-radiological parameters may be worthy of future consideration within the tribal baseline monitoring program, major emphasis must be placed upon a thorough definition of radiological parameters since the primary regulatory standards for the high-level nuclear waste repository program are predicated on the basis of radiation doses to humans.

Primary air sampling will be performed for airborne radioactive particulates. Air samplers also will be capable of sampling for radioactive iodine by adding a charcoal canister filter in the sampler when these measurements are deemed necessary. Both filters would be taken to a laboratory for radiochemical analysis.

Based on currently postulated release scenarios, amounts of airborne tritium (H-3) or the radioactive noble gases (xenon, krypton) from currently postulated atmospheric release scenarios that could impact the CTUIR study area presently are not considered significant. It is, therefore, not proposed to sample for airborne tritium or krypton-85 (Kr-85) during the first year of the tribal environmental baseline monitoring program. In addition, the foregoing airborne radionuclides are not expected to be important contributors to the total radiation levels in the CTUIR study area, in the event of an accidental release.

External direct gamma radiation will be measured continuously at selected sites using pressurized ion chambers (PICs) and/or thermoluminescent dosimeters (TLDs). Portable survey meters will be used to make short term or instantaneous measurements as crosschecks or for situations such as a site-specific transportation accident. The TLDs are used to make an integrated measurement of the radiation received over a relatively long period of time such as a month, a quarter year, or a year. The TLD must taken to a reader unit (usually in the laboratory) to obtain the dose measurement. The PIC dose measurements can be read out on a real time basis but are usually recorded by any of several methods. The recorded data is then taken to the laboratory for analysis or integration to obtain daily, monthly, or yearly exposure levels.

3.1.1.3 <u>Proposed Atmospheric Monitoring Sites</u> The proposed environmental monitoring sites will be located as follows:

- Meteorological/Climatological

  Due to the wide variations in both meteorological and climatological parameters anticipated within the CTUIR study area as a consequence of its relatively complex physiography, two permanent meteorological climatologic monitoring stations are proposed for the tribal environmental baseline monitoring program. Consequently, a permanent meteorological station would be located on the north side of Mission, Oregon at approximately the pipeline crossing of the Umatilla Mission Highway. The station would use a 10-meter tower and be equipped to measure wind speed, wind direction, temperature, solar radiation, dew point, precipitation, and evaporation. Peripheral equipment required includes a custom instrument shelter with air conditioning (to protect data acquisition equipment), backup generator or other power source, lightning arrestor, and a data acquisition system.

  A portable meteorological station would be used initially to gather baseline data at the radio repeater site located off Emigrant Scenic Road near Boiling Point. This location would provide baseline data for transportation accidents which might occur on Cabbage Hill. The portable station would use a 3-meter tower and would be equipped to collect wind speed, wind direction, and temperature. Peripheral equipment would include a mobile trailer (instrument shelter), batteries and/or portable generator, and data acquisition system.

- Air Sampling

  One air sampler would be located in Mission, Oregon near the CTUIR tribal offices.

- One spare sampler would be used for quality assurance, for backup, and for use at transportation accident sites. It will also be rotated to gather baseline data at Cayuse and Gibbon.

- Pressurized ion chambers (PICS)

  One PIC would be located in Mission, Oregon with the air sampler near the tribal offices.

  A second PIC would be purchased as a spare instrument for backup for both the CTUIR and the Nez Perce programs. This PIC would be kept at the Council of Energy Resource Tribe office when not in use. It would be used as part of the quality assurance program and for gathering baseline data at different locations on both reservations.

- Thermoluminescent dosimeters (TLDs)

  TLD stations would be located in Mission, Cayuse, Gibbon, and Meachum, Oregon. Multiple TLDs would be located at each station for quality assurance.

3.1.2 Hydrologic Monitoring Program

Both the physical and chemical characteristics of the waters of the CTUIR study area are important in the determination of the effects of possible contaminant releases. The principal exposure pathways to individuals or groups of individuals in the environment from waterborne contaminants are ingestion of drinking water, consumption of fish, various aquatic species, and consumption of irrigated crops. For example, should a radionuclide release occur on the land surface or into a surface body of water, ground water due to seepage and surface water via runoff become direct exposure pathways to the tribal populations. Of secondary importance are external radiation from surface water (swimming, boating, skiing), from sediment deposits along the shoreline, or from deposits on an irrigated field. However, the radiation doses from these external sources are generally several orders of magnitude less important than pathways leading to ingestion.

If a radiological release should occur into waters of the study area, it is important that there is a good understanding of the overall chemistry of the waters. This section delineates the overall hydrologic monitoring program which is proposed for the CTUIR study area. In the development of such a monitoring program, it is important to

recognize that due to the size of the study area, one monitoring program cannot develop a data base comprehensive enough to address all of the potential impacts of a high-level nuclear repository at Hanford. It is proposed that the data base developed by the tribe be combined with existing federal and state data bases to serve the study needs. In this proposed program, an effort was made to minimize the duplication of effort with federal and state agencies currently performing hydrologic studies in the area. In addition, a combined effort on behalf of the Nez Perce and CTUIR will be required to develop such a regional program.

The following briefly describes a number of existing monitoring programs being carried out within the proposed CTUIR study area. In addition, the proposed hydrologic monitoring program for the Umatilla Tribe is described. This program details a relatively comprehensive sampling program of the study area waters and sediment for not only radionuclides but also major cation and anions and additional parameters which identify the overall quality of the streams.

3.1.2.1 Existing Monitoring Programs. The following is a brief discussion on the various hydrologic monitoring programs currently obtaining data within the study area. Because, in the development of any monitoring program, access to various existing data bases is important, a summary of federal water information data is also presented. Additional information on the data available from these programs was presented in the Scoping Study (CERT, 1985) and will not be discussed in detail.

Numerous hydrologic monitoring programs are currently under way in the vicinity of the Hanford Reservation. The United States Department of Energy is funding several studies which will determine the suitability of BWIP for a high-level nuclear repository. The United States Geological Survey (USGS) maintains several surface water stations which monitor flow and water quality of the region's rivers and streams. The USGS is also involved in a Regional Aquifer System Analysis Program (RASA) which has been designed to delineate the groundwater characteristics of the Columbia River Basalts. Table 3-1 outlines other ongoing USGS programs in the region. Other agencies with ongoing hydrologic monitoring programs in the region include the Oregon Department of Health, the state of Washington, the United States Bureau of Reclamation, the Corps of Engineers, the United States Forest Service, and several other scientific organizations.

Table 3-1. USGS ONGOING PROJECTS WITHIN THE CTUIR HYDROLOGIC MONITORING PROGRAM STUDY AREA

Project	Principal Investigators	Approximate Project Completion Date
Groundwater Flow Model Simulation of the Columbia River Basalt, South-central Wash. and North-central Oregon w/Parts of Idaho (RASA)	Hanley, Whitman, Vaccaro	6/86
Water Quality Characteristics of Selected Geohydrologic Units in the Columbia River Basalt, South Washington, North Central Oregon and parts of Idaho	Steinkanph	12/85
Groundwater Levels in Three Basalt Hydrologic Units Overlying the Columbia Plateau, Washington and Oregon	Whitman	Completed
Geology, Structure and Thickness of Selected Hydrologic Units in the Columbia River Basalts	Gonthier	Completed
Deep Percolation Model Columbia River Basalt	Vaccaro	Completed
Estimation of Predevelopment and Current Recharge to the Columbia River Basalt Regional Groundwater System	Bauer	12/85
Groundwater Pumpage in the Columbia River Plateau, Washington	Cline	12/85
Groundwater Pumpage in the Columbia River Plateau, Washington	Collins	12/85

Table 3-1. USGS ONGOING PROJECTS WITHIN THE CTUIR HYDROLOGIC MONITORING PROGRAM STUDY AREA (Continued)

Project	Principal Investigators	Approximate Project Completon Date
Surface water and surface water/groundwater for the Columbia River, Plateau, Central Washington and North Central Oregon.	Nelson	1/86
Summary Appraisal of the Columbia River Plateau Regional Aquifer	Vaccaro	6/87
Geohydrologic Framework of the Columbia River Regional Aquifer System Washington, Oregon, and Idaho.	Whitman, Gonthier Bauer, Nelson, Collins, Cline and Vaccaro	8/86
The Geochemical Framework of the groundwater in the Columbia River Regional Aquifer System.	Steinkanph	12/86
Hydrology of the Columbia River Regional Aquifer System	Hansen, Whitman Vaccaro and Bauer	3/87

One of the objectives of the tribe's High-Level Nuclear Waste Monitoring Program is to design a hydrologic monitoring program which will be useful to the tribe in assessing the impact of a high level nuclear repository located at Hanford. In the preparation of such a program, it was felt that, if implemented, the program should complement and enlarge the existing regional data base.

As presented in the Scoping Study (CERT, 1984), the hydrologic data base for the reservation is limited in terms of water quality and quantity. There are no baseline data for the radiochemistry of the surface and ground waters for the reservation and a long term data base for other water quality parameters is limited. The USGS, however, does maintain surface water flow monitoring stations on the main rivers within the reservation.

In the study area outside the reservation, hydrologic monitoring is somewhat more extensive. The USGS maintains several stations and a few monitoring wells. The United States Forest Service maintains monitoring stations in the National Forests. These stations are limited to a relatively few years of record and usually monitor only flow and sediment load. The United States Bureau of Reclamation (USBR) maintains flow monitoring and water quality stations for USBR dams. The Army Corps of Engineers also maintains monitoring stations at its dam sites along the Columbia and Snake Rivers. The USDOE has an extensive groundwater and surface water program within the Hanford Reservations and along the Hanford reach of the Columbia River.

The states of Washington and Oregon also are monitoring water quality (including radionuclides) along the Columbia River and, to a lesser extent, along other rivers in the region. An Oregon state-wide surface water radiological surveillance program was established on a routine basis in 1962. The state of Washington has established a similar type program. The tribe also performs limited surface and groundwater monitoring within the reservation to obtain data for its fisheries program.

A comprehensive list of regional environmental radiation monitoring programs is presented in Appendix A. Map 2 illustrates the locations of the monitoring stations of these various organizations. Triangles denote surface water monitoring stations. The numbers within the symbol indicates which organization is responsible for maintaining the station. A list of addresses, contacts and basic information on the environmental monitoring systems of these various organizations is presented in Appendix B.

DATA BASES. As presented in the Scoping Study (CERT, 1984), monitored baseline environmental data are available for both water quality and quantity within the study area. The principal data bases for these compilations are WATSTORE and STORET.

The National Water Data Storage and Retrieval System (WATSTORE) was established by the USGS in 1971 to provide an efficient data base retrieval of water quality and quantity data from approximately 10,000 stream gauging stations, 4,300 water quality stations and numerous lakes, reservoirs, and wells. Inexpensive output files are available from USGS Water Resources Offices. Available compilations include daily flow values, peak flow data, water quality data, groundwater inventory information, reservoir and lake levels, and several statistical packages which aid in interpreting and correlating the data. Although it is possible to gain direct access to the WATSTORE system, it is not considered user friendly and data is sometimes difficult to interpret.

A second computerized data base for hydrologic baseline environmental data is STORET. STORET is the United States Environmental Protection Agency's computerized water quality data base. STORET contains data on water quality samples taken from more than 200,000 collection points. Input to data files is derived from state, local, and various federal agencies. Nearly all of the water quality data collected in the CTUIR study area is documented within the STORET data system. Direct access to the STORET data base for the tribe is a distinct possibility. Training on direct utilization of the STORET data base is available from the EPA since water quality data input from the proposed tribal monitoring program would be encouraged.

A third hydrologic data base management system is currently accessible within the study area. The system is called the Hydromet system and is currently operated by the USBR. Hydromet involves the collection and telemetry of water quality and quantity data from various reservoirs and stream gauging stations associated with projects being operated by the Bureau of Reclamation as well as the Corps of Engineers. This computerized system has been designed to be extremely user friendly and can be directly accessed. One of the advantages of this system as compared to WATSTORE is that "real time" data can be readily obtained. Using a communications modem, the user can interrogate a particular station via a computer to obtain a reading at any point in time. This ability allows the user to determine the state of station operability and to obtain current data for operation and maintenance of municipal, irrigation, and fisheries water supplies and streamflows.

Basic information on each of these computerized data base systems is given in Appendix C. It must be emphasized that in the development of a hydrologic monitoring program for the tribe, it is essential that a data base be developed and utilized that is compatible with one or more of the above regional data systems. At this time, direct access to both the STORET and Hydromet systems appears to be feasible.

As with the development of any hydrologic monitoring program, the program design plays an important role in determining how successful the program will be. The program must have clear objectives. Sampling sites locations must be planned in such a way as to meet the overall objectives of the program. The selection of parameters to be monitored must be made so that seasonal or other changes in the chemical quality of the monitored streams (or aquifers) can be identified. Finally, a data base must be developed so that data input is simple and easily learned; statistical reduction of the data is possible; and trends in the data can be delineated. The following presents the design for the CTUIR Indian High-Level Nuclear Waste Program's Hydrologic Monitoring Plan.

The preliminary objectives of the hydrologic monitoring plan are presented as follows:

- The monitoring program must be specifically designed to study the impacts of the potential siting of a high-level nuclear waste repository at Hanford, Washington, on the waters of the CTUIR study area.

- Because transportation of nuclear waste through the CTUIR study area is of primary concern, the monitoring program should concentrate along major transportation routes (i.e. interstate highway and rail routes).

- Another area of concern is the effect that a transportation accident may have on the tribe's fisheries. The collection of baseline hydrologic data, especially during low flow periods, on streams which are important to the tribe's fishery program should be incorporated in the overall design of the monitoring program.

- The hydrologic program monitoring program should be designed, if possible, to benefit other tribal water programs, including fishery restoration, water rights management, and environmental protection.

- The data base developed from such a monitoring program must be acceptable to federal and state scientific organizations with care being taken to follow a strict quality assurance/quality control (QA/QC) program which will be compatible with the program as outlined for contractors being used by the DOE at Hanford Reservation.

To meet these objectives, a hydrologic monitoring program has been designed. The following paragraphs outline the proposed monitoring stations for both surface and groundwater; define water quality parameters; and develop data base requirements. QA/QC protocols and procedures are presented in a separate, subsequent section of this report.

3.1.2.2 Definition of Parameters for Tribal Hydrologic Monitoring Program. Both radiological and non-radiological water quality parameters are defined for the proposed tribal hydrologic program within the CTUIR study area.

Water Quality Parameters

Water quality and quantity monitoring of the streams and wells at the various stations over the next several years will aid the tribe in developing a regional data base. As with any water quality monitoring program, the selection of chemical parameters and frequency of sampling are of primary importance.

Tables 3-2 through 3-6 present the proposed surface water quality parameters and frequency of monitoring for the various stations. As delineated in these tables, permanent stations will be monitored on a monthly basis with a more comprehensive analyses being performed on a quarterly and yearly schedule. Low-flow stations will be sampled only once a year.

Due to the paucity of available water chemistry data for the surface waters in the CTUIR study area, basic information on the seasonal trends and fluctuations in the concentrations of major anions, cations, and trace metals is required to determine the overall activity of the waters. Other parameters such as total suspended solids and total organic carbon are required to establish the relative degree of anthropogenic contamination.

The most important aspect of the tribal monitoring program is the determination of baseline radioactivity of the study area streams and groundwater. The radionuclides listed in the Tables 3-2 through 3-6 are those which most likely would be present in the waters should a release occur. Admittedly, most of the parameters to be monitored on a yearly basis at permanent stations will probably not be present in the current samples. However, should a release occur, it is important to have available baseline levels of these radionuclides for comparison.

Radionuclides will be mónitored on a monthly and quarterly basis at the permanent stations, on a yearly basis for low flow stations, and on a semiannual basis for wells. An abrupt increase in the radioactivity levels of these samples will indicate possible contamination from a release. Should an increase in the activity of any of these parameters occur over a threshold limit, measures will be taken to identify the specific source and affected parameters.

Sediment samples will also be taken at the permanent stations on a yearly basis. These samples will be measured for radionuclides only. The parameters to be measured will be the same as those monitored for the soil samples.

3.1.2.3 Proposed Monitoring Sites As previously mentioned, hydrologic data is lacking for both surface water and groundwater throughout the CTUIR study area. Water quality data is available from studies which were relatively short-lived. Except along the Columbia near the Hanford Site, little data are available to establish baseline radiological characteristics of either the surface and ground water in the study area. Additional water quality and quantity data are required to fully delineate the potential risk of radioactive contamination of surface and groundwater should an accident occur which could impact the study area and to characterize the rivers and streams throughout the study area, especially during low-flow periods.

The study area for the CTUIR High Level Nuclear Waste Program covers over 10,000 square miles and encompasses the Umatilla Indian Reservation as well as the CTUIR ceded lands. Due to the size of the study area, it is very difficult to design and implement a comprehensive monitoring program that is both cost effective and manageable. A hydrologic monitoring program has, therefore, been designed to concentrate monitoring sites along the major transportation routes within the reservation

Table 3-2. PROPOSED SURFACE WATER QUALITY PARAMETERS TO BE MONITORED AT PERMANENT GAUGING STATIONS ON A MONTHLY BASIS UMATILLA INDIAN HIGH-LEVEL NUCLEAR WASTE PROGRAM

Field Parameters

pH (pH units)
Specific conductivity at 25 degrees C (um hos/cm)
Temperature (degrees C)
Dissolved oxygen (mg/l)
Flow (cfs)

Laboratory Parameters

Radionuclides (pCi/l):

Gross Alpha
Gross Beta

Miscellaneous

Total dissolved solids (TDS)
Total suspended solids (TSS)
Total organic carbon (TOC)
Nitrate-nitrite (as N)
Ammonia (as N)
Phosphate (PO4 as P)

Table 3-3. PROPOSED SURFACE WATER QUALITY PARAMETERS TO BE MONITORED AT PERMANENT GAUGING STATIONS ON A QUARTERLY BASIS UMATILLA INDIAN HIGH-LEVEL NUCLEAR WASTE PROGRAM

Field Parameters

pH (pH units)
Specific conductivity at 25 degrees C (um hos/cm)
Temperature (degrees C)
Dissolved oxygen (mg/l)
Flow (cfs)

Laboratory Parameters

Major Cations and Anions (Dissolved species concentration):

Alkalinity (total and bicarbonate)
Sulfate (SO4)
Chloride (Cl)
Fluoride (F)
Sodium (Na)
Magnesium (Mg)
Potassium (K)
Calcium (Ca)

Trace Metals (Total and dissolved species concentration):

Aluminum (Al)Lead (Pb)
Arsenic (As)Manganese (Mn)
Cadmium (Cd)Mercury (Hg)
Copper (Cu)Molybdenum (Mo)
Iron (Fe)Zinc (Zn)

Radionuclides (pCi/l):

Gross Alpha
Gross Beta
Strontium (89) & (90)
Tritium (enriched)
Uranium (238)

Miscellaneous

Total dissolved solids (TDS)
Total suspended solids (TSS)
Total organic carbon (TOC)
Nitrate-nitrite (as N)
Ammonia (as N)
Phosphate (PO4 as P)
Hardness

It should be noted that the parameter list will be subject to change upon determination of background levels.

Table 3-4. PROPOSED GROUND WATER QUALITY PARAMETERS TO BE MONITORED ON A SEMI-ANNUAL BASIS UMATILLA INDIAN HIGH-LEVEL NUCLEAR WASTE PROGRAM

Field Parameters

pH (pH units)
Specific conductivity at 25 degrees C (um hos/cm)
Temperature (degrees C)
Dissolved oxygen (mg/1)
Flow (cfs)

Laboratory Parameters

Major Cations and Anions (Dissolved species concentration):

Alkalinity (total and bicarbonate)
Sulfate (SO4)
Chloride (C1)
Fluoride (F)
Sodium (Na)
Magnesium (Mg)
Potassium (K)
Calcium (Ca)

Trace Metals (Total and dissolved species concentration):

Aluminum (A1)
Arsenic (As)
Cadmium (Cd)
Copper (Cu)
Iron (Fe)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Molybdenum (Mo)
Zinc (Zn)

Radionuclides (pi/1):

Gross Alpha
Gross Beta
Americium (241)(243)
Cesium (134)(137)
Chromium (51)
Cobalt (60)
Iodine (131)
Neptunium (237)
Manganese (54)
Plutonium (238)(239)
Promethium (147)
Radium (226)(228)
Strontium (89)(90)
Technetium (99)
Thorium (23)(232)
Tin (126)
Tritium (enriched)
Uranium (234)(235)(238)

Miscellaneous

Total dissolved solids (TDS)
Total suspended solids (TSS)
Total organic carbon (TOC)
Nitrate-nitrite (as N)
Ammonia (as N)
Phosphate (PO4 as P)
Hardness

It should be noted that the parameter list will be subject to change upon determination of background levels.

Table 3-5. PROPOSED SURFACE WATER QUALITY PARAMETERS TO BE MONITORED AT PERMANENT GAUGING STATIONS ON A YEARLY BASIS UMATILLA INDIAN HIGH-LEVEL NUCLEAR WASTE PROGRAM

Field Parameters

pH (pH units)
Specific conductivity at 25 degrees C (um hos/cm)
Temperature (degrees C)
Dissolved oxygen (mg/1)
Flow (cfs)

Laboratory Parameters

Major Cations and Anions (Dissolved species concentration):

Alkalinity (total and bicarbonate)
Sulfate (SO4)
Chloride (C1)
Fluoride (F)
Sodium (Na)
Magnesium (Mg)
Potassium (K)
Calcium (Ca)

Trace Metals (Total and dissolved species concentration):

Aluminum (A1)	Lead (Pb)
Arsenic (As)	Manganese (Mn)
Cadmium (Cd)	Mercury (Hg)
Copper (Cu)	Molybdenum (Mo)
Iron (Fe)	Zinc (Zn)

Radionuclides (pi/1):

Gross Alpha	Plutonium (238)(239)
Gross Beta	Promethium (147)
Americium (241)(243)	Radium (226)(228)
Cesium (134)(137)	Strontium (89)(90)
Chromium (51)	Technetium (99)
Cobalt (60)	Thorium (230(232)
Iodine (131)	Tin (126)
Neptunium (237)	Tritium (enriched)
Manganese (54)	Uranium (234)(235)(238)

Miscellaneous

Total dissolved solids (TDS)
Total suspended solids (TSS)
Total organic carbon (TOC)
Nitrate-nitrite (as N)
Ammonia (as N)
Phosphate (PO4 as P)
Hardness

It should be noted that the parameter list will be subject to change upon determination of background levels.

Table 3-6. PROPOSED SURFACE WATER QUALITY PARAMETERS TO BE MONITORED DURING LOW-FLOW AT SELECTED STATIONS UMATILLA INDIAN HIGH-LEVEL NUCLEAR WASTE PROGRAM

<u>Field Parameters</u>

pH (pH units)
Specific conductivity at 25 degrees C (um hos/cm)
Temperature (degrees C)
Dissolved oxygen (mg/1)
Flow (cfs)

<u>Laboratory Parameters</u>

Major Cations and Anions (dissolved species concentration):

Alkalinity (total and bicarbonate)
Sulfate (SO4)
Chloride (C1)
Fluoride (F)
Sodium (Na)
Magnesium (Mg)
Potassium (K)
Calcium (Ca)

<u>Trace Metals (Total and dissolved species concentration):</u>

Aluminum (A1)
Arsenic (As)
Cadmium (Cd)
Copper (Cu)
Iron (Fe)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Molybdenum (Mo)
Zinc (Zn)

Radionuclides (pCi/1)

Gross Alpha
Gross Beta
Strontium (89)(90)
Tritium (enriched)
Uranium (238)

<u>Miscellaneous</u>

Total dissolved solids (TDS)
Total suspended solids (TSS)
Total organic carbon (TOC)
Nitrate-nitrite (as N)
Ammonia (as N)
Phosphate (PO4 as P)
Hardness

It should be noted that the parameter list will be subject to change upon determination of background levels.

and to perform sampling and measurements during low-flow periods for rivers and streams that are used by the CTUIR tribes for fishing throughout the study area. Data from these monitoring stations will be correlated with data compilations from existing federal and state monitoring programs in order to satisfy the data requirements of the CTUIR environmental baseline monitoring program.

The proposed surface water monitoring program is divided into two phases. The first phase is the development of permanent gauging stations within the reservation (see Figure 3-1). The proposed surface water monitoring program is divided into two phases. The first phase is the developement of permanent gauging stations within the reservation (see Figure 3-1). In order of priority, these stations would be located on the Umatilla River on the western boundary of the reservation, on Meacham Creek near the intersection of the creek and Interstate 84, upstream and downstream on Patawa Creek near Interstate 84, and on Squaw and Buckaroo Creeks near their confluence with the Umatilla River (see Map 2). Each of these drainages could be adversely affected by an accident causing a release of radioactive wastes on the major transportation routes through the reservation.

The Umatilla River gauging station is the most important surface water monitoring site. The Union Pacific Railroad Line runs along this river and the Umatilla River is the main drainage for the area. The upstream portion of the Umatilla River is gauged by the USGS. Additional water quality monitoring is required there. A permanent station installed on the western boundary of the reservation would serve the tribe in water rights protection as well as provide a suitable location for water quality monitoring for the High Level Nuclear Waste Program. The USGS has been contacted in regard to installing such a station. USGS cooperation is considered important for QA/QC and should be possible.

Meacham Creek near Interstate 84 is the second most important site. The Meacham Creek flood plain serves as the route for the Union Pacific Railroad and also is a viable fishing stream for the tribe. The downstream portion of Meacham Creek is currently monitored by the USGS near Gibbons and additional water quality monitoring would be required at this station.

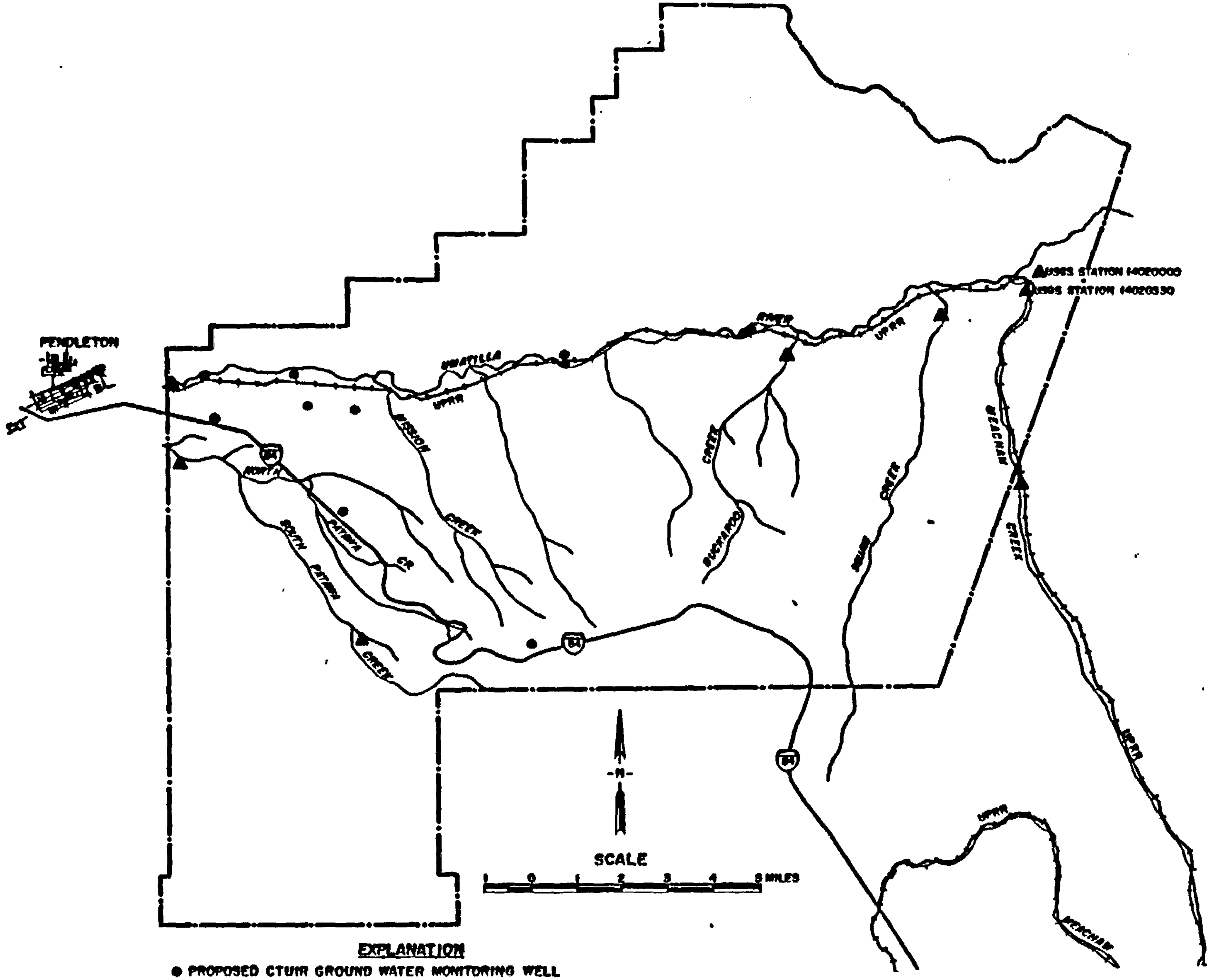


Figure 3-1 PROPOSED SURFACE WATER MONITORING NETWORK WITHIN THE CTUIR RESERVATION

Patawa Creek runs parallel to Interstate 84 in the Cabbage Hill Area. Due to the history of accidents along this highway, monitoring of surface quality and quantity is quite important at this location.

The other two drainages, Squaw and Buckaroo Creeks, also receive runoff from Interstate 84. Both of these streams support fishing and are considered important to the tribe's fishery program.

In terms of the design for the monitoring programs, most gauging stations will consist of a staff gauge with a surveyed cross-section. The station near the western boundary of the reservation on the Umatilla River will be designed and installed in cooperation with the USGS. Water quality and quantity will be monitored by tribal personnel on a monthly basis. The existing USGS stations will also be monitored monthly for water quality.

The second phase of the hydrologic monitoring program is the development of a low-flow baseline water quality and quantity data base for the entire study area. The low-flow period during summer and fall for most streams is considered extremely important for fishery development and is the time most harm could occur to fish habitats due to a release. This program has been designed to sample and gauge streams throughout the study area during this critical low-flow period during the next five years. As listed in Table 3-7 and presented on Map 2, thirty sites have been defined to be of importance for low-flow monitoring. These sites, some of which correspond with the Nez Perce Program, will be monitored on a yearly basis by tribal personnel and will be bench marked to insure continuity of data.

GROUND WATER

Detailed geologic and geohydrologic studies with the study have been undertaken by both the USGS and DOE Richland. The USGS is currently compiling geohydrologic data for the Regional Aquifer Analysis (RASA) Project. RASA involves delineation of the effects of structure and stratigraphy on the regional ground water system in the Columbia River Basalt. Studies by DOE Richland mainly concentrate around the BWIP site.

Currently, there are over 600 wells drilled on the CTUIR reservation. Little information is available on most these wells due to poor lithologic logs and completion records. It is

Table 3-7. PROPOSED CTUIR SURFACE WATER MONITORING STATIONS
CTUIR HIGH-LEVEL NUCLEAR WASTE PROGRAM

Station	T	R	Sec.
1. Monthly monitoring stations			
UMATILLA RIVER BASIN (Oregon)			
Umatilla River at Eastern Boundary (USGS station 14020000)	3N	36E	21
Meacham Creek near 184	1S	36E	2
Meacham Creek near Gibbons (USGS station 14020330)	3N	36E	31
North Fork Patawa Creek near 184	1N	33E	2
North Fork Patawa Creek (downstream)	2N	33E	7
Buckaroo Creek near confluence w/ Umatilla River	2N	34E	9
Squaw Creek near confluence w/ Umatilla River	2N	35E	9
2. Yearly Low-Flow Monitoring Statons			
JOHN DAY RIVER BASIN (Oregon)			
Clear Creek	9S	35E	2
Granite Creek	8S	35E	19
North Fork John Day River	8S	35E	18
North Fork John Day River	7S	31E	2
Desolation Creek	7S	32E	6
Camas Creek	6	31E	20
GRANDE RONDE RIVER BASIN (Oregon)			
Grande Ronde River (USGS station 1331900)	2S	37E	36
Catherine Creek	3S	39E	14
Lostrine River (USGS station 1330000)	3S	39E	14
Wollowa River	1N	43E	19
Wallowa River	2N	41E	29
Minam River (USGS station 13331500)	2N	41E	30
Looking Glass Creek (USGS station 13324300)	3N	39E	13
Jarboe Creek	3N	40E	7
Grande Ronde River (USGS station 13332500)	3N	40E	13
Wenaha River			
IMNAHA RIVER BASIN (Oregon)			
Little Sheep Creek	1N	48E	29
Imnaha River	1N	48E	28
Imnaha River (USGS station 13329200)	1N	48E	16

Table 3-7. PROPOSED CTUIR SURFACE WATER MONITORING STATIONS CTUIR HIGH-LEVEL NUCLEAR WASTE PROGRAM (continued)

Station	T	R	Sec.
TUCANNON RIVER BASIN (Washington)			
Tucannon River	11N	40E	12
UMATILLA RIVER BASIN (Oregon)			
North Fork Umatilla River	3N	37E	14
South Fork Umatilla River	3N	37E	28
Meacham Creek	1N	36E	24
Umatilla River (USGS station 14021000)	2N	32E	10
McKay Creek (USGS station 14022200)	1S	33E	1
McKay Creek (USGS station 14023500)	2N	32E	23
Birch Creek	2N	32E	19
Umatilla River (USGS station 14033500)	5N	28E	23
WILLOW CREEK BASIN (Oregon)			
Willow Creek (USGS station 14036000)	3N	22E	12
WALLA WALLA RIVER BASIN (Washington)			
Walla Walla River (USGS station 14018600)	7N	33E	36

felt that during the next five years several additional wells will be drilled on the reservation. The tribe understands the importance of the RASA Project recognizing that good geologic logs and completion records on the reservation could assist the delineation of the Columbia River Basalt in the area. It is proposed that, during the next several years, at least sixteen wells drilled in various portions of the reservation be geologically logged with completion formations being determined by DOE contractors.

Since the wells will be drilled at the landowner's expense, only interpretation costs will be necessary.

In addition, the tribe is currently monitoring water levels on eleven wells which are within the reservation. The location of these wells are presented in Table 3-8 and Map 2. Because of the proximity of the foregoing wells to specific transportation routes, it is proposed that these wells be rehabilitated and monitored for water quality and water levels on a semiannual basis.

DATA BASE DEVELOPMENT

One of the most important aspects of the tribal monitoring program is the development of a long-term data base for the two types of data that will be collected during the proposed Hydrologic Monitoring program; i.e., water quality data and continuous flow data. Water quality data could be stored on the High-Level Nuclear Waste Program's microcomputer, an IBM PC compatible. The microcomputer provides an inexpensive method of storing the data in an easily accessible form. A good microcomputer data base will facilitate data entry, storage, and analysis, and will permit reporting of the data in both textual and graphic formats. Continuous flow data will be stored on a more sophisticated system which involves a mainframe computer. This will allow for the storage of much more data.

3.1.3 Soil Radiation Monitoring Program

The purpose of soil radiation monitoring surveys is to determine background radiation and the long-term build-up of radionuclides in soils. These radionuclides could come from air-, rainfall-, or surface water-borne transport from naturally-occurring sources of radioactivity, from fallout, from Hanford operations, or from transportation of nuclear waste through the study area.

3.1.3.1 Existing Monitoring Programs. The U.S. Department of Energy has established a soil monitoring program for areas on and near the Hanford Reservation. Soil samples are collected annually at 15 sites within the Hanford Reservation and at 18 offsite locations. Most of the latter are located east and southeast of Hanford and within several miles of the reservation boundaries. More distant sites are, however, located at Walla Walla and McNary Dam near Benton City and Sunnyside in the Yakima Valley. All of the soil samples are tested in a laboratory operated by U.S. Testing Company, Inc., in Richland, under a DOE-approved quality-assurance program. This means that samples are sent on a regular basis to other laboratories for comparison testing and that equipment is calibrated regularly using National Bureau of Standards techniques. The radionuclides tested include cesium-137 and other gamma-emitting isotopes, strontium-90, plutonium 239/240, and total uranium. This testing program was established at Hanford in 1971 and has continued each year since that time. Results of the tests are published annually by Pacific Northwest Laboratories.

The states of Washington and Oregon operate radiation monitoring programs that are separate from the DOE program, but Oregon does not currently test routinely for soil radiation. Washington has a soil monitoring program in the southeastern part of the state that is limited to annual sampling at four sites at the U.S. Ecology low-level radioactive waste site and at five sites at the WPPSS-2 (WNP-2) nuclear power plant, both located on the Hanford Reservation (Peterson & Mooney, 1984). At U.S. Ecology, Washington, tests for gamma-emitting isotopes (Cs-137, Zr-95, Zn-65, K-40, Co-60), gross alpha, and gross beta. At WPPSS-2, they test for gamma (Cs-137, Zr-95, K-40, Co-60), strontium-89/90, and gross beta. During 1986, Washington collected soil samples at additional locations on the Hanford Reservation and at one location in the Sunnyside area. Analyses will be performed for Sr-90, gamma-emitting isotopes and for gross alpha and beta. The state of Idaho has no radiation monitoring program currently operating in the northern half of the state (Bob Funderburg, Idaho Division of Health, personal communication, 3/14/86). The Environmental Radiation Ambient Monitoring System (ERAMS), operated by the U.S. Environmental Protection Agency, monitors some radionuclide parameters in Portland, Seattle, Spokane, Boise, and Idaho Falls, but does not monitor soil radioactivity (E.P.A.,. 1985).

3.1.3.2 Proposed Soil Monitoring Program. The most susceptible soils to long-term impacts from build-up of radionuclides are those alluvial or wetland soils which exist along streams used for fishing or surface water supplies, act as recharge areas for

Table 3-8. PROPOSED CTUIR GROUNDWATER MONITORING WELLS

LOCATION	AQUIFER	OWNERSHIP	USE
T2N R33E SEC 9	Alluvium	CTUIR	Observation Well
T2N R34E SEC 4	Alluvium	CTUIR	Observation Well
T2N R34E SEC 4	Basalt	CTUIR	Observation Well
T2N R35 SEC 6	Alluvium	CTUIR	Observation Well
T2N R35E SEC 6	Basalt	CTUIR	Observation Well
T2N R33E SEC 7	Basalt	Private	Domestic
T2N R33E SEC 10	Basalt	Private	Public
T2N R33E SEC 11	Alluvium	Private	Dom./Irrigation
T1N R34E SEC 9	Basalt	Private	Domestic
T2N R33E SEC 27	Basalt	Private	Domestic
T2N R33E SEC 17	Basalt	Private	Domestic

alluvial wells, or are used for farming, ranching, or hunting. This is due to the potential for human ingestion of radionuclides present in drinking water and food. Because anadromous fish, wild game, and wild roots and berries provide a substantial part of the CTUIR diet, the potential exists for major impacts from radionuclide releases in sparsely populated areas. Since these tribes also reside, drink well water, and raise livestock and crops along the stream valleys containing these alluvial soils, the potential impact is compounded. These stream valleys also usually contain the major transportation routes.

For the above reasons, the areas to be monitored for radionuclides are alluvial soils located along major nuclear waste transportation routes together with the present Indian fishing and hunting areas within the traditional CTUIR possessory and usage rights area. These soils have the following characteristics:

Soil type—Typic Haploxeroll, sandy skeletal, mixed, mesic
Profile—Organic horizon ....0"
  Brown, extremely cobbly and
  gravelly fine sandy loam,
  granular, n-sti, n-pls.......0-14"
  Cobble gravel.............14"
Range-10-60" depending on channel and condition
Water retention capacity—5-20"
Slope—1-5%
Erosion type—flood and severe channel erosion
Erosion rate—generally high
Ground cover—0-50%
Plant community—moist meadow and quaking aspen meadow
Rock outcrops—50%
Suitability—grazing, agriculture, hunting, fishing.

The soil sampling stations on the CTUIR study area will be located near the following streams:

• Umatilla River near Pendleton	T2N	R32E	SEC.10

• Meacham Creek near Gibbons	T3N	R36E	SEC.31
• Meacham Creek near I-84 and UPRR	T1S	R36E	SEC.2
• Patawa Creek, North Fork, near I-84	T1N	R33E	SEC. 2
• John Day River, North Fork, at Camas Creek	T7S	R31E	SEC. 2
• Tucannon River near Zumwalt, WA	T11N	R40E	SEC. 12

3.1.4 Vegetation and Milk Radiation Monitoring Program

The purpose of vegetation and milk radiation monitoring surveys is to determine background radiation and the build-up of radiactive isotopes in mature annual and perennial vegetation. These radionuclides could come from air-, rainfall-, or surface water-borne transport from naturally-occurring sources of radioactivity, from fallout, from Hanford operations, or from transportation of nuclear waste through the CTUIR study area.

3.1.4.1 Existing Monitoring Program. The U.S. Department of Energy has established a vegetation monitoring program for areas on and near the Hanford Reservation. Samples of perennial vegetation, such as rabbitbrush, sagebrush, and bitterbrush were collected in 1985 at 14 sites within the Hanford Reservation and at 16 offsite locations. Most of the latter are located east and southeast of Hanford and within several miles of the reservation boundary. Two more distant sites, however, are located near Benton City and Sunnyside in the Yakima Valley. Samples of food crops, such as wheat, alfalfa, fruit, leafy vegetables, meat and eggs, and milk are also collected in the Riverview, Sagemoor, Wahluke East, Benton City, Sunnyside, Cold Creek, and Moses Lake areas, which surround the Hanford area. All of the samples are tested in a laboratory operated by U.S. Testing Company, Inc., in Richland under a DOE-approved quality-assurance program. This

means that samples are sent on a regular basis to other laboratories for comparison testing and that equipment is calibrated regularly using National Bureau of Standards techniques. Vegetation samples are tested for gamma-emitting radionuclides, strontium 90, plutonium, and uranium. The milk samples, which are collected biweekly in the Sagemoor and Sunnyside areas and monthly elsewhere, are tested for gamma, and strontium-89/90, with selected milk samples being analyzed for tritium and iodine-129. Fruit in 1985 was analyzed for tritium, strontium-90, and cesium-137. Other foodstuffs were analyzed for strontium-90 and cesium-137.

The Oregon Division of Health has had an Environmental Radiation Surveillance Program since 1961 which includes sampling stations within the CTUIR study area. This program includes vegetation monitoring stations near the towns of Umatilla, LaGrade, Wallowa, and Dayville. Milk monitoring stations are located in the Baker-La Grande Valley, the Boise Valley (Ontario-Payette-Weiser area), and the Redmond area. Laboratory testing similar to that of DOE is performed in the state radiation laboratory in Portland.

The Oregon Division of Health has had an Environmental Radiation Surveillance Program since 1961 which includes sampling stations within the CTUIR study area. This program includes vegetation monitoring stations near the towns of Umatilla, LaGrade, Wallowa, and Dayville. Milk monitoring stations are located in the Baker-Law Grande Valley, the Boise Valley (Ontario-Payette-Weiser area), and the Redmond area. Laboratory testing similar to that of DOE is performed in the state radiation laboratory in Portland.

For the above reasons, the vegetation stations to be monitored for radionuclides will be located on riparian croplands along major transportation routes and on public lands near present Indian root gathering and hunting areas within the traditional CTUIR possessory and usage rights area. These samples will be taken in areas where soil samples are being taken, which are, in turn, located near water quality monitoring stations. The primary vegetation types to be sampled include annual crops such as wheat and alfalfa hay, wild root plants such as camas and kouse, and perennial upland steppe vegetation such as sagebrush and rabbitbrush. Dairy herds will be monitored only on the Umatilla reservation due to the location of existing state monitoring programs outside the reservations.

The vegetation stations on the CTUIR study area will be located near the following streams:

• Umatilla River near Pendleton	T2N	R32E	SEC.10	wheat
• Meacham Creek near Gibbons	T2N	R32E	SEC.10	wheat
• Meacham Creek near I-84 and UPRR	T1S	R36E	SEC.2	alfalfa
• Patawa Creek, North Fork, near I-84	T1N	R33E	SEC. 2	wheat
• John Day River, North Fork, at Camas Creek	T7S	R31E	SEC. 2	kouse
• Tucannon River near Zumwalt, WA	T11N	R40E	SEC. 12	sagebrush

Milk samples will be collected quarterly from the herds in the Pendleton (T2N, R32E) and Gibbons (T3N, R36E) areas on the CTUIR reservation.

The Washington Division of Health monitors vegetation in two locations in the southeastern part of the state. At the U.S. Ecology low-level radioactive waste disposal site, the state monitors perennial native vegetation at each of the four corners of the site. Tested on an annual basis are such parameters as gross alpha and gross beta and such gamma-emitters as Ru-106, Cs-137, Zr-95, Zn-65, K-40, and Co-60 (Peterson & Mooney, 1984). At Pasco, the state tests onions and cabbage on an annual basis as part of its WPPSS-2 monitoring program for Cs-134/137, I-131, and K-40. These milk samples—from three farms in Pasco and one farm in Sunnyside—are tested for I-131, Sr-90, Ba-140, Cs-137, and K-40. In early 1983, the state ended its testing of strontium-90 in milk and will concentrate future testing on iodine-131 and the gamma-emitters.

The state of Idaho collects no radiation data for vegetation or milk, but depends on existing federal government programs for all such monitoring (Bob Funderburg, Idaho Division of Health, personal communication, 3/14/86). The U.S. Environmental Protection Agency collects radiation data for the northwest through its national

Environmental Radiation Ambient Monitoring System (ERAMS). Although no vegetation monitoring is included in this program, a national pasteurized milk monitoring program has been established in cooperation with the Food and Drug Administration (E.P.A., 1985). Such milk monitoring stations have been established at Idaho Falls, Portland, Seattle, and Spokane, none of which are within close proximity to Hanford. Samples from these stations are tested monthly for I-131, Cs-137, K-40, and Ba-140 and a regional composite of these samples is tested for Sr-89/90. Annually nine stations with wide national geographic distribution are tested for carbon-14.

3.1.4.2 Proposed Vegetation and Milk Monitoring Program. Vegetation most susceptible to radionuclide buildup includes upland vegetation and crops which exist downwind (south and east) from the Hanford Reservation, and riparian vegetation and crops near major transportation routes. Much of the land containing these types of vegetation is used for farming ranching, or hunting. Because these tribes live, hunt, and raise beef and dairy cattle, sheep, and crops along the stream valleys containing the major transportation routes, the potential impact from transportation accidents could be serious. Milk, as well as vegetation, needs to be monitored in these areas because milk is a primary indicator of airborne, short-lived iodine isotopes which are difficult to determine from other surveys. Since wild game, roots, and berries provide a substantial part of the CTUIR diet, major impacts could also occur from radionuclide releases in sparsely populated areas.

3.1.5 Fish and Wildlife Resources.

Fish and wildlife found in the CTUIR study area are valuable resources to the tribes. To help protect this resource, a sampling program is proposed to establish baseline levels of selected radionuclides in animal, fish, and bird species harvested by tribal members.

3.1.5.1 Existing Monitoring Programs. The existing programs for monitoring radioactivity in the Hanford environs are referenced in Appendix A. The appendix shows that the USDOE is monitoring program samples of wildlife on the Hanford site and fish in the Columbia River. The state of Washington has two fish sampling stations in the Columbia River near the Hanford site.

A cooperative effort to rehabilitate the anadromous fishery in the Umatilla, John Day, and Grande Ronde rivers basins began in 1983. This project involves the CTUIR, the U.S. Fish and Wildlife Service, the U.S. Bureau of Reclamation, the U.S. Forest Service, the National Marine Fisheries Service, the Bonneville Power Administration, and the Oregon Department of Fish and Wildlife. Determination of the existing anadromous fishery resources of these river basins, the extent of the problems affecting the fish population, the production potential and site-specific recommendations to restore the historically significant fishery have been part of this effort. CTUIR has begun implementing plans to restore fish habitat within the study area, with the cooperation of the other participating agencies.

The Bureau of Indian Affairs has several wildlife and habitat studies in progress within the diminished boundaries of the CTUIR reservation. The first of these studies, to be completed on October 1, 1986, defines existing upland and riparian vegetation and habitat types for the common big game mammals. These data will be digitized on a computerized geographic information storage and retrieval system. A second BIA study, to be released in November 1986 will define counts, habitat, and migration routes for mule deer within the reservation. This study is part of a graduate thesis research project, sponsored by BIA, which included aerial herd counts and radio transmitter tagging surveys of 15 deer on the reservation. A similar report is to be releasd during the spring of 1987 on the white-tailed deer population of the reservation. Other studies in progress at BIA include a three-year project to monitor habitat use and migration routes of elk and continuing census work for pheasant and quail. Previous census work (spring 1985) on elk indicate that at least 6000 elk are present within only the portion of the reservation south of I-84. Similar surveys will begin north of the interstate this winter. Although bald eagles, osprey, and peregrine falcons have been sighted within the diminished reservation boundaries, no funding has been specifically ear-marked for threatened and endangered species studies. All of these studies will be utilized in determining the baseline wildlife conditions for the Nuclear Waste Program, but none of them currently sample for the presence of radionuclides in wildlife.

3.1.5.2 Proposed Monitoring Program. Several kinds of wildlife will be sampled on an "as available" basis. These are:

deer	fish (several species)
waterfowl	crayfish (if available)

upland game birds   mussels (if available)
rabbits

The emphasis is to be placed on sampling edible species which may make up a significant portion of the diet of tribal members. Since the location of traditional hunting and fishing sites are generally not public knowledge, sampling locations and species to be sampled will be selected by the Tribal Nuclear Waste Program staff.

Where available, samples will be collected semiannually. At least two samples of each species sampled should be collected from different locations during each sampling period.

3.2 SAMPLING METHODOLOGIES

All of the preferred sampling methodologies outlined in the section of the report will be designed to fully comply with currently prescribed federal and state procedures within each monitoring discipline.

3.2.1 Atmospheric

In addition to continuous monitoring of the major climatological and meteorological parameters (wind speed, wind direction, wind stability, barometric pressure, ambient temperature, relative humidity, precipitation, etc.) air sampling and selected atmospheric radiation monitoring measurements will be conducted at or near to the proposed atmospheric monitoring sites described previously in Section 3.1.1.3. Since atmospheric transport constitutes the most direct potential pathway for both external and internal radiation dose to humans, major emphasis will be placed on the baseline measurement of atmospheric radiation in the areas of highest tribal population densities.

Strict DOE-approved QA/QC procedures and protocal will be followed for all planned atmospheric monitoring activities. Preliminary requirements for radiological baseline monitoring measurements include the following:

- Air sampling

Air samples require a mininum of at least two cubic feet of air per minute passing sequentially through a paper filter and activated charcoal canister. Filter diameter should not be less than 47 millimeters. Charcoal canisters are used to measure radioactive iodine in air and are placed in the sampler only when airborne radioiodine is suspected or as a part of the quality assurance program. The particulate radionuclides are collected on the paper filter along with any non-radioactive dust in the air being sampled. Filters should be changed either twice or three times per week (may depend on dust loading). Each filter will need to sample a minimum of about 300 cubic meters of air in order to collect enough radioactivity on the filter to permit laboratory analysis. Air samplers should each be provided with a vacuum gauge and flow rate meter. The system should be mounted in an all-weather shelter with sampler discharge located so as to prevent recirculting of air. Primary laboratory calibration equipment for the air samplers will consist of either a wet test meter, a dry gas meter, a spirometer, or a venturi meter calibration kit.

Several types of particulate filter media are available. Examples are paper, fiberglass, polystyrene, and charcoal impregnated cellulose. Some types such as fiberglass may contain some natural radioactivity such as uranium or radium and should be avoided for some applications. The type of filter media selected also depends on the air mover chosen, sampling flow rate, the length of sampling period, dust loading, pressure drop, and financial constraints.

Air filters will be field checked for radioactivity content with a portable Geiger-Mueller GM survey meter after removal from the air sampler. After filters have been transferred to the laboratory, they will be checked for gross alpha and gross beta radioactivity content. If the filter samples show elevated gross radioactivity levels, they will be given a gamma scan to assess levels of gamma-emitting radionuclides. If gross alpha and beta levels are not elevated, samples will be routinely composited on a quarterly basis for gamma scan followed by radiochemical analysis for uranium -234 and -238, plutonium-239, americium-241, and strontium-89 and-90. Gamma scans will identify such radionuclides as beryllium-7, cesium-137, manganese-54, and cobalt-60.

- Pressurized Ion Chambers

  Pressurized ion chambers will usually be operated at a fixed location at about one meter above the ground. The PIC operates continuously to measure gamma radiation at that location. The data is typically reported in units of microroentgens or milliroentgens per hour. It can be reported digitally, on chart recorder, or on cassette tape. While not classed as a truly portable instrument, the PIC can be transported from one location to another to obtain baseline gamma background data. The spare PIC would be used for this purpose and to cross-check the permanent stations.

- Thermoluminescent Dosimeters

  Environmental TLDs are typically placed about one meter above the ground on a stake or stand. Each TLD station package will contain from three to five TLD chips. Each chip can be read separately for quality control. TLDs can be read monthly, quarterly, or yearly. For these studies, the TLDs will be read monthly for the first year and quarterly thereafter.

- Portable Radiation Survey Meters

  A portable gamma ray scintillometer capable of measuring exposure rates down to a few microroentgens per hour will be acquired. A Geiger-Mueller portable survey meter with two interchangeable probes will also be acquired. The probes will be a pancake probe and a gamma probe with a beta shield. The instruments will be used for making field check measurements with the PICs and TLDs and for making field check measurements on air filters. The instruments will also be available for use at transportation accidents.

3.2.2 Hydrology

All water samples will be collected and analyzed using EPA, USGS, or DOE-approved methods. Samples will be preserved; placed in coolers on ice; and sent to the designated laboratory using strict QA/QC procedures. In the laboratory, the same precautions will be taken and analysis techniques will be used as designated by the Pacific Northwest

Laboratory and DOE for water samples taken in and near the Hanford Reservation. Again, compatability with DOE, EPA, and NRC QA/QC protocols and procedures will be required of the selected laboratory. The QA/QC program will be discussed in a subsequent section of this report.

Prior to the implementation of the monitoring program, a detailed procedures manual will be developed. This manual will instruct the tribal monitoring personnel on the proper way to obtain flow data, to measure water levels in wells, and to collect and preserve samples. In this manual, guidelines will also be given to the laboratory on analytical techniques to be used and minimum detection limits to be expected.

One of the primary concerns of any monitoring program is that sampling errors be kept to a minimum. Upon the implementation of the monitoring program, an instructor will train the tribal monitoring personnel on the procedures outlined in the manual. In-field instruction will be a part of the overall program. A QA/QC program, which is to be implemented, will provide checks on the effectiveness of the training program.

3.2.3 Soil Sampling Methodology and Analytical Procedures

3.2.3.1 Sampling Technique. One sample will be taken annually at each sampling station location. The sample will consist of a composite of 5 plugs of soil 2.5 cm deep and 10 cm in diameter collected within a 100-meter square area. A minimum dry weight of one kilogram is required for each composite soil sample. Profile samples will be collected as a function of soil depth at selected locations.

3.2.4 Vegetation and Milk Sampling

3.2.4.1 Sampling Schedule and Technique. One vegetation sample will be taken quarterly for the first year, and annually each year thereafter, at each perennial plant sampling location. Perennial plants and wild root plants will be sampled annually in late spring during the period of budding and rapid growth. Annual crops, such as wheat and alfalfa, will be sampled at maturity in late summer or early fall. The samples will consist of cuttings of sufficient new growth from perennial vegetation or sufficient annual plants to make up a one kilogram bag sample collected within a 100 meter-square area. Five milk samples of 7 liters per sample will be collected quarterly from tribal herds on each reservation.

Milk will also be analyzed for gamma-emitting radionuclides, tritium, and strontium-89/90, but iodine-129/131 analyses will be added.

3.2.5 Wildlife

Several kinds of wildlife will be monitored. These include deer, fish, upland game birds, waterfowl, and rabbits. Wild game animals, birds, and fish normally constitute only a small part of man's diet and hence may contribute only a small amount to his radiation exposure. Since tribal members may consume larger quantities of game than the average non-tribal individual, the significance of the exposure pathway is correspondingly greater.

Samples will be collected on an as available basis. Local game wardens can help with samples of road kills or of confiscated game. Tribal hunters and fishermen may be willing to sell or donate a portion of their game. Fisheries personnel can help provide samples.

Samples to be collected should consist primarily of edible flesh (muscle) with some liver and bone samples from deer.

Samples should be frozen as soon as possible after collection to control decay and for ease in laboratory analysis. Samples will be analyzed by gamma spectroscopy for potassium-40, cesium-137, and cobalt-60. Gamma spectroscopy will require about 500 grams of meat. Radiochemcial separation after ashing of the meat will be followed by alpha spectroscopy for plutonium 238, 239, and 240 and for uranium 234 and 238. A radiochemical separation will also be performed for strontium 89 and 90. Generally the meat will be ashed to reduce the volume before radiochemical separation of the radionuclides is performed. About 600 grams of meat will be required for these analyses.

Since fish apparently play an important role in tribal diet, representative samples of all species consumed should be obtained. If mussels or crayfish are eaten then samples of these species should also be obtained for analysis.

3.3 QA/QC PROTOCOLS AND PROCEDURES

The most important aspects of any environmental monitoring program are the reliability and acceptability of the field and laboratory data collected during the program. This is also important in the design of the High-Level Nuclear Waste Monitoring Program. At BWIP, DOE and NRC should insure that quality control is a continuing commitment of all managers at all levels in the Office of Geologic Repositories Program. This commitment must be shared by the tribe in the implementation of the proposed environmental monitoring program.

Such a program is not easy to develop, requiring both time and an understanding of the overall objectives of the program. Quality Assurance and Quality Control (QA/QC) are project-wide tasks, with each person in the project aware of the requirements of the program. Attention must be paid to detail, and documentation of every task performed must be rigorous. If this is not done, the following types of problems (which have been documented for one of the DOE repository projects may arise:

- Improper indoctrination and training.
- Non-retention of all training records.
- Lack of documentation of work activities as procedures.
- Inadequate test instructions.
- Inconsistencies in sample identification.
- Inconsistencies in describing test samples.
- Lack of retrievability and traceability of samples and testing
- Absence of written concurrence of the Program Manager at decision points.
- Lack of timely audits.

- Lack of timeliness and performance of corrective actions.

- Inappropriate resolution of audit comments.

In order to prevent such occurrences,a QA/QC plan must be implemented prior to the initiation of any sampling or testing. The following section describes the salient characteristics of a QA/QC plan.

3.3.1 QA/QC Plan

Development of an overall QA/QC plan is beyond the scope of this environmental monitoring plan. It is, however, proposed that before beginning implementation of the monitoring program, a QA/QC manual be developed. This manual will be written by the tribe, with the assistance of CERT and DOE, and will be concerned with—but not limited to the following issues:

- Personnel Indoctrination and Training—qualification and training of personnel performing monitoring activities in the fields of meteorology,air sampling, external dose measurement, hydrology, soils,fisheries and wildlife, and vegetation and milk.

- Technical Specifications—quality control, including preventative maintenance, calibration, and chain of sample custody procedures, for purchasing and operating monitoring equipment and computer software, and for sample collection, shipping, and storage.

- Subcontractor QA/QC Plans—procedures for reviewing and approving QA/QC plans for all tribal subcontractors, including testing laboratories, where QA may include sample splitting, blind testing, and observation of procedures.

- Document Control—control procedures, including chain of custody, for all data collection and analysis records.

- Technical and Peer Reviews—review of technical procedures, reliability of data, and results and conclusions by a committee of qualified, independent reviewers.

- Surveillance and Audit Procedures—establishment of procedures for periodic internal surveillances by the QA/QC manager and for formal QA audits by the manager,if he is certified as an auditor, or by an outside contractor, if the manager is not certified.

- Nonconformances, Corrective Actions, and Stop Work Orders—formal procedures for taking corrective action on nonconforming items documented in the surveillance and audit reports.

The tribe's QA/QC program will be developed in conjunction with the QA/QC program to be implemented by DOE for the site characterization phase at BWIP. If the data collected by the tribe is to be deemed acceptable by DOE, the state of Washington, and other users of a common regional data base, such a rigorous QA/QC program is imperative.

3.4 ENVIRONMENTAL MONITORING PROGRAM COSTS

3.4.1 Cost Estimating Procedure

In estimating costs for the High Level Nuclear Waste Program's proposed environmental monitoring program plan, two categories—one-time costs and annual costs—must be considered. One-time costs will include such capital costs as monitoring station equipment and installation and certain training costs related to data base management familiarization. Annual costs will include recurring expenditures for labor, travel, laboratory analyses, etc., that will occur each year for the duration of the environmental monitoring program.

One of the most important aspects of any monitoring program is training technical personnel to carry out the program in a cost effective, but quality conscious manner. The proposed Environmental Monitoring Program will be managed by the tribal High-Level Nuclear Waste Program Manager. Training of the Nuclear Waste staff is important to the Program and will be performed by the staff of the Council of Energy Resource Tribes and its consultants, under the supervision of the CERT Nuclear Waste Project Manager. This training program will include a short course on sampling techniques, field

instruction on equipment use, and the development of a field manual. Included in the training costs is the development of a data base management (DBM) system for the tribe's existing Nuclear Waste microcomputer system. Because a quality DBM system can be readily and inexpensively purchased off the shelf, the majority of the costs for the system will be for installing the system and training personnel in the effective use of the system.

The Environmental Monitoring Program will require two full-time technical personnel and four part-time personnel. The Program Manager will be responsible for administering the Environmental Monitoring Program and for maintaining the Quality Assurance Program. A Tribal Technical Coordinator reporting to the Program Manager will provide day-to-day oversight and coordination of the Environmental Monitoring Program Staff. The Technical Coordinator will spend about 40% (0.4MY) of his time in this capacity. The Technical Coordinator will supervise the other monitoring personnel, reporting to the Program Manager regularly. He will also be responsible for maintaining quality control in the sampling and data entry program. The duties of the full-time personnel (2 Staff environmental Technicians) will include collecting air, water, soil, vegetation, milk, and wildlife samples and making radiation measurements at the permanent environmental monitoring stations and sites, assisting in the training of the part-time personnel, entering data into the DBM system, performing field testing, and preparing and sending samples to the contract laboratories. The part-time personnel will be used to sample the once-yearly sampling stations, such as the soil monitoring sites and the low-flow stream sampling stations, during the summer and early fall. Detailed job descriptions for these positions will be written by the Program Manager, with the assistance of CERT. Part-time personnel will consist of two Environmental Technicians (0.25 MY each), one Staff Wildlife Biologist (0.5 MY), and one Wildlife Biologist (0.5 MY). A summary of personnel costs is shown in Table 3-9.

Finally, each of the full-time monitoring personnel will be provided with a four-wheel drive pick-up equipped with a two-way radio. This type of vehicle is needed because the study area includes approximately 10,000 square miles, much of it in rugged, mountainous terrain far from major roads or population centers. A two-way radio base station is planned for the Nuclear Waste Program Office. The estimated cost (Table 3-10) for the vehicles includes vehicle leases and radio maintenance.

All costs are given in 1986 U.S. dollars and have not been adjusted for inflation.

Table 3-9. ENVIRONMENTAL MONITORING PROGRAM PROPOSED MANPOWER REQUIREMENTS

Position	Person - Years	Cost
Tribal Technical Coordinator	0.40	$16,000
Staff Environmental Technician	1.00	16,000
Staff Environmental Technician	1.00	15,000
Environmental Technician	0.25	4,000
Environmental Technician	0.25	4,000
Fisheries Biologist	0.50	12,500
Wildlife Biologist	0.50	12,500
	Subtotal	$81,000
Fringe Benefits (24%)		$19,940
Travel (10 trips @ $9,500/trip)		$9,500
	TOTAL	$110,440

Table 3-10. MISCELLANEOUS COSTS

Annual Lease Costs

Vehicles	Lease Cost
Four-wheel drive pickup (2)	$32,200/year*

* Cost includes lease, fuel, and maintenance of two-way radios.

Maintenance

Item	Lease Cost
USBR Satellite Links	$8,050/year **

** Maintenance costs for satellite links for gauging stations providing real-time flow data (Hydromet System).

External Radiation Dosimeters

Item	Lease Cost
Thermoluminescent Dosimeters (TLDs)	$1,000/year***

*** Cost for monthly exchange for TLD dosimeters for 9 stations.

3.4.2 Atmospheric Monitoring Costs

Atmospheric monitoring equipment includes meteorological equipment and supplies for monitoring meteorological and climatological parameters. It also includes air sampling and external dose measuring equipment and supplies. Thermoluminescent dosimeters (TLDs) would be rented and exchanged on a monthly basis. Costs are shown in Tables 3-9, 3-10, and 3-11.

Air sample filters will be given a gross alpha beta count after collection. Filters will be composited quarterly and analyzed by gamma scan and for uranium, plutonium, strontium, and americium. Additional analysis may be performed as indicated by gross alpha/beta analysis or by quarterly gamma scan. Charcoal filters will be added to air samples when indicated by reports of radionuclide releases.

3.4.3 Hydrologic Monitoring Costs

Hydrologic monitoring equipment is required to do field measurements for flow and water quality analyses plus the filtration of samples prior to the determination of dissolved constituents in the laboratory. As proposed in the section 3.1.2.2 (Proposed Monitoring Program), one permanent monitoring station is to be installed to monitor the Umatilla River at the western boundary of the reservation. It is estimated by the USGS that it would cost approximately $15,000 to install such a station. For real time flow data, it was proposed in the data base development section of this report that the two existing USGS stations on the Umatilla River and Meacham Creek and the proposed station on the Umatilla River become part of the USBR Hydromet System.

Annual expenditures include water quality analyses and maintenance of equipment. Costs for the water quality analyses were based on the proposed parameter lists provided in Section 3.1.2.2 and on costs given by U.S. Testing Company, Inc., Richland, Washington. Annual Maintenance costs for the gauging stations were provided by the USGS and the USBR.

Table 3-11. CAPITAL EQUIPMENT EXPENDITURES

Item	Cost
Two-way radio system	$5,750
USBR Hydromet Link (2 hydroelectric equipment units @ $4,025/unit)	8,050
Analog portable pH/mv lab with buffer solutions	775
Conductivity meter (hydrologic)	815
Dissolved oxygen meter (hydrologic)	625
Six mercury thermometers	120
Hydrologic field alkalinity equipment	615
Hydrologic field equipment accessories (wash bottles, beakers, bod bottles, glass prefilters, 0.45 micron filters)	990
Hydrologic magnetic flow meter	3,220
Misc. equipment (fish, wildlife, soil & vegetation sampling)	1,150
Portable refrigerator(fish, wildlife, food & water samples)	1,150
Analytical balance (sample weighing)	2,300
One permanent meteorological stations ($35,000/ea.) (includes 10m tower, wind speed & direction sensors, dew point & temperature sensors, precipitation gauge, evaporation pan, data acquisition system (DAS), custom shelter, and lightening sensor)	35,000
One portable meteorological station (3m tower, wind speed, wind direction & temperature sensors, data acquisition system (DAS), portable trailer, and lightening arrestor)	17,500
Two air samplers (with flow calibrator)	2,990
Two pressurized Ionization Chambers (PICs)	30,000
Two portable radiation survey meters (1 scintillometer and 1 GM counter)	2,300
Total	$113,350

3.4.4 Soils, Vegetation, Milk, and Other Foodstuffs Monitoring Costs

Samples for soil and vegetation radiation monitoring will be collected at the same 6 sampling locations throughout the environmental monitoring program. One surface soil sample will be collected from each station annually, beginning in the first year of the program, but vegetation will be sampled quarterly during the first year and annually thereafter at each of the 6 sites. Profile soil samples will be collected at selected locations. Soils samples will be analyzed in a radiation testing laboratory for gamma, plutonium, strontium, and uranium. Vegetation and foodstuff samples will be analyzed initially for gamma, tritium, and stronium. Additional analysis may be performed for the radionuclides depending on analytical results from the first samples.

Stream-bottom sediment samples will be collected during Hydrologic Monitoring at the surface water sampling stations. Because these samples are more similar in composition and testing procedure to soil samples than to water samples, the analysis costs are considered here. These nine samples per year will be analyzed for the same radioisotopes as the soil samples.

About 25 samples of foodstuffs will be collected for analysis. Types of samples to be collected will depend on availability but tentatively could include 6 vegetable samples, 3 fruit samples, 3 berry samples, 1 wheat sample, 3 samples of root crops, samples, 1 chicken sample, and one milk sample. Analytical costs are shown in Table 3-12.

3.4.5 Wildlife Monitoring Costs

All specimans will be analyzed for cesium-137, gamma emitting radionuclides, strontium, uranium, and plutonium.

Wildlife monitoring costs assume two samples each on an annual basis from the following species:

- deer
- rabbits
- pheasant
- salmon
- sturgeon
- bass

Table 3-12. LABORATORY ANALYSIS EXPENDITURES*

Item	Cost
Water quality laborayory analysis	
Surface water (perennial stations)	
Monthly	$27,600
Quarterly	28,750
Yearly	16,100
Surface water (low flow stations) Yearly	20,700
Split water samples for QA/QC	9,200
Fish, wildlife sample preparation and laboratory analysis (9 wildlife species and 4 fish species, yearly)	20,370
Soil laboratory analysis	7,080
Sediment laboratory analysis	6,600
Vegetation laboratory analysis	4,920
Food samples - laboratory analysis (25 samples yearly)	14,750
Air laboratory analysis (filter change 3 times/week)	7,100
Air - composite quarterly analysis	4,365
TOTAL SAMPLE PREPARATION/LABORATORY ANALYSIS EXPENDITURE (1st year)	$167,535

*Includes cost of sample preparation and quality assurance (except for water samples which is shown separately).

chukar   steelhead

ducks

4 presently unidentified species.

3.4.6 Total Monitoring Program Costs

Total laboratory analysis costs for the entire first-year CTUIR environmental baseline monitoring program are summarized in Table 3-12. A total program cost summary is presented in Table 3-13.

3.5 TRIBAL ENVIRONMENTAL MONITORING PROGRAM-PROJECT ORGANIZATION AND PROGRAM SCHEDULE

To ensure effective management and control of the proposed environmental baseline monitoring program, a tribal project organization has been formulated. The proposed project organization, as presently envisioned, is briefly outlined in this section of the environmental surveillance plan. In addition, a proposed schedule for the tribal environmental baseline monitoring program, including major milestones, is also provided.

3.5.1 Tribal Project Organization

The proposed tribal project organization to conduct the CTUIR environmental baseline monitoring program is presented in Figure 3-2. As indicated in Figure 3-2, the tribal program manager has the primary responsibility for the environmental monitoring program. The technical coordinator, however, has the direct line responsibility for oversight and coordination of the tribal environmental staff which includes two full-time staff environmental technicians and two part-time environmental technicians, who will provide assistance to the permanent environmental staff during the three-month summer season. The part-time environmental technicians will, therefore, lend additional support to the permanent staff during the peak period for environmental sampling and data collection.

Table 3-13. ENVIRONMENTAL MONITORING PLAN - COST SUMMARY

Item	Cost
Tribal Personnel Costs	$110,440/year
Lease Costs	41,250/year
Analytical Costs (lst year)	167,535/year
Capital Equipment	113,350/year
Total	$432,575

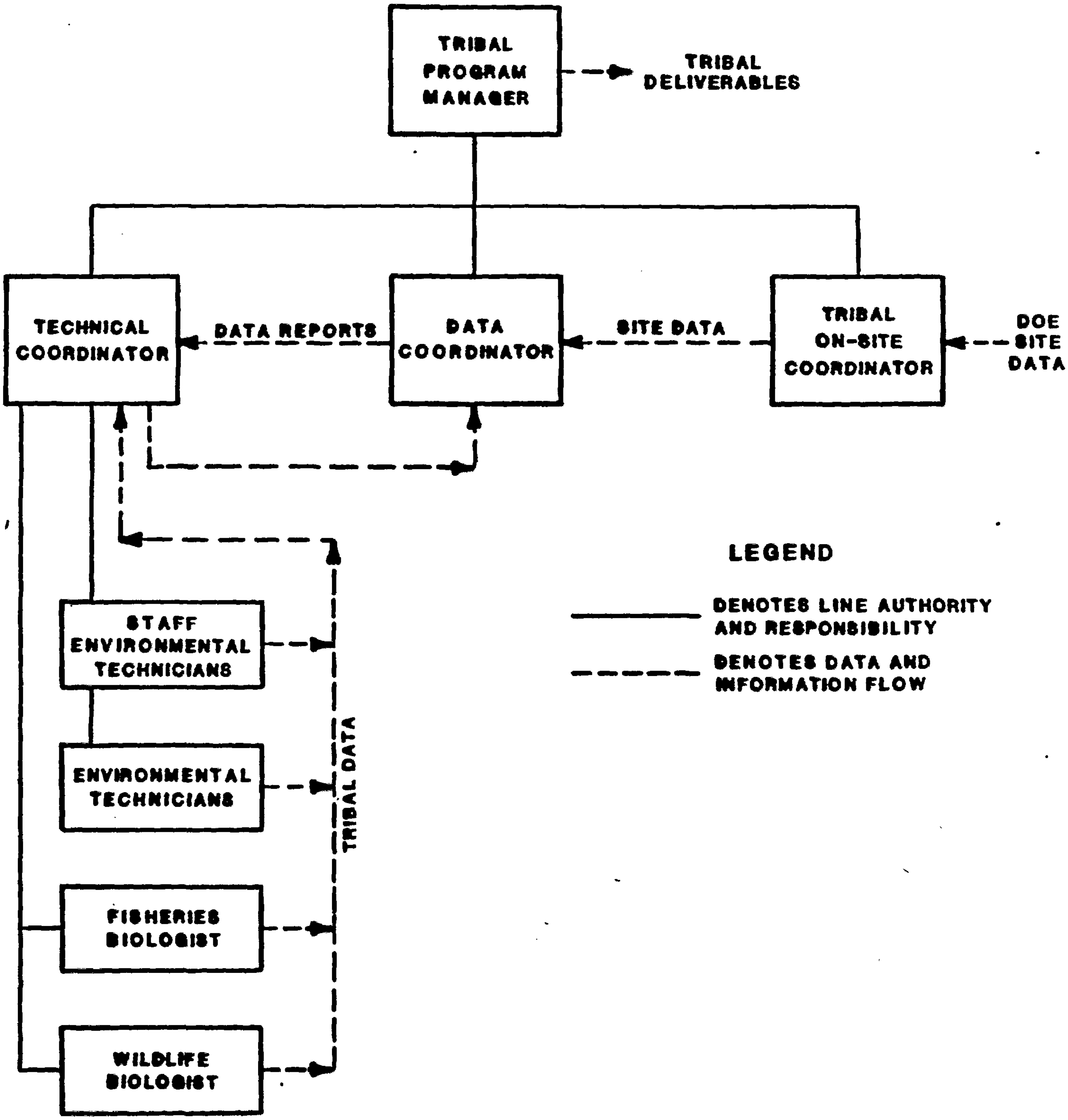


Figure 3-2. TRIBAL PROJECT ORGANIZATION - ENVIRONMENTAL MONITORING PROGRAM - NUCLEAR WASTE POLICY ACT

The technical coordinator will have day-to-day responsibility for supervision of all the environmental technicians as well as cognizance over all environmental monitoring equipment and its associated operation and maintenance.

All the monitored data developed within the tribal environmental baseline monitoring program will be collected and assembled by the tribal environmental staff into a report which will be forwarded initially to the data coordinator on at least a quarterly basis. The data coordinator will review the data reports for completeness and compliance with established reporting procedures set forth in the pre-established tribal environmental monitoring program procedures manuals and the accompanying quality assurance/quality control procedures manuals. Pending the approval of the data coordinator, the data reports will then be directed to the tribal technical coordinator for overall technical review prior to final transmittal to the tribal program manager.

In addition, two professional biologists from the ongoing tribal natural resources program will participate in the proposed tribal environmental baseline monitoring program in the specific areas of the program related to fish and wildlife, reporting directly to the tribal technical coordinator. Direct responsibilities for and detailed knowledge of the ongoing tribal fish and wildlife programs will provide the proposed environmental monitoring programs with necessary, additional expertise in these highly important disciplines.

Although not shown in the schematic of the project organization in Figure 3-2, the CERT technical staff will be available to support the CTUIR tribal program manager and the tribal environmental review committee in every facet of the proposed environmental monitoring program as outlined in Section 3.0 of this plan.

3.5.2 Tribal Environmental Monitoring Program Schedule (First Year)

A preliminary schedule for the first year of the proposed tribal environmental baseline monitoring program is presented in Figure 3-3. Only major planned program activities and milestones are outlined in Figure 3-3.

- Equipment and Laboratory Analyses Procurement. During this activity, monitoring equipment for meteorology, hydrology, and the other fields will be procured. The laboratory which will be used for analytical work will also be chosen.

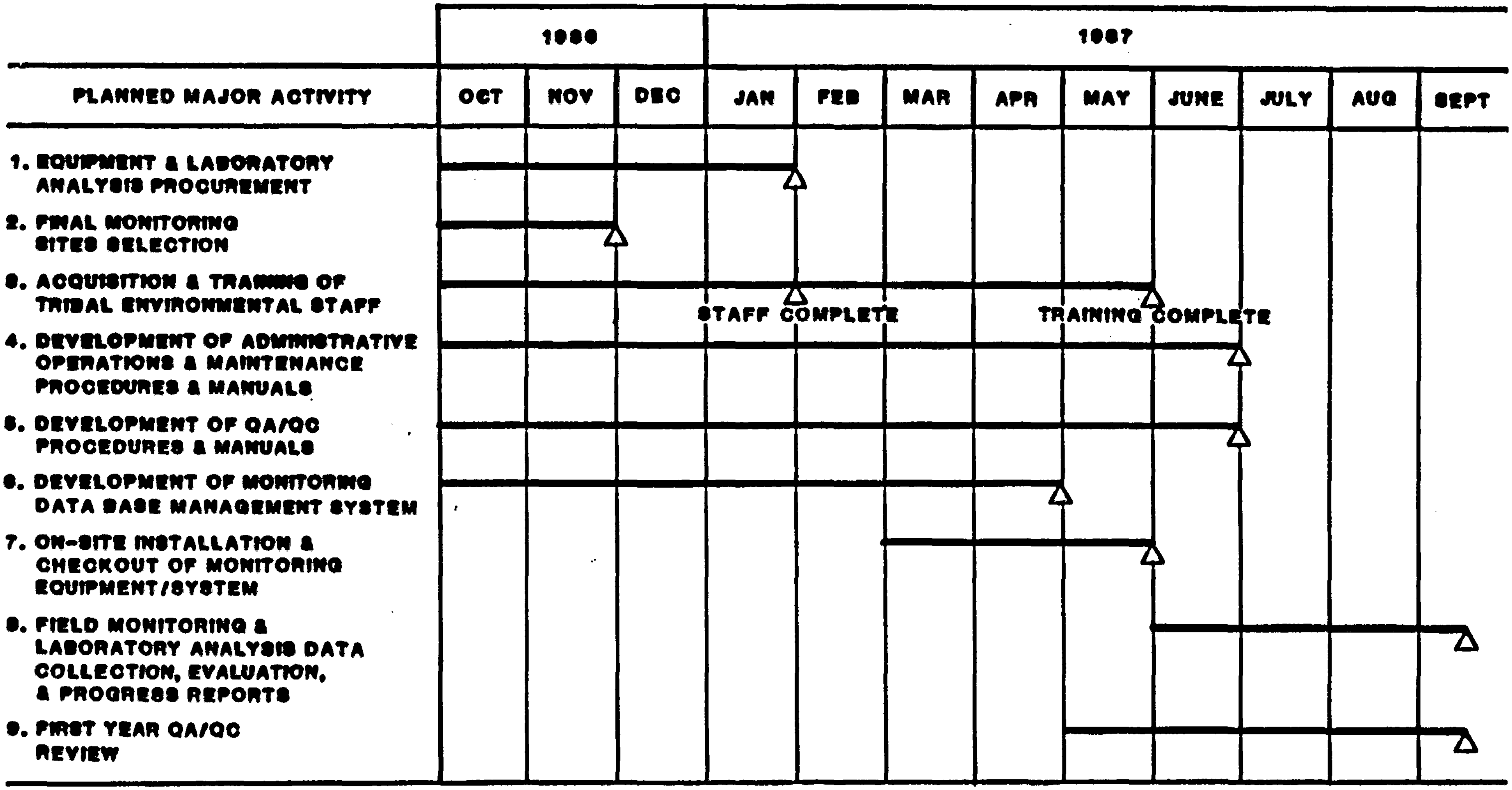


Figure 3-3. TRIBAL ENVIRONMENTAL BASELINE MONITORING PROGRAM MAJOR PROGRAM ACTIVITIES SCHEDULE AND MILESTONES FY 1987

- Final Monitoring Site Selection. This is a very important activity. In previous sections of this chapter, preliminary sites were designated. During this task, these sites will be checked for suitability, accessibility and land ownership. Upon final selection, the sites will be identified and located on maps.

- Acquisition & Training of Tribal Environmental Staff. This task will involve a search for qualified personnel who will reasonable for maintaining the monitoring programs for each field. Once hired, these personnel will take part in a comprehensive training program.

- Development of Administrative, Training, & Maintenance Procedures and Manuals. With any monitoring program, it is important that standard policies, procedures, and practices are established for administering the program, collecting the data, and maintaining the equipment. During this task, manuals will be developed for training the environmental staff on proper procedures to be used in the monitoring program.

- Development of QA/QC Procedures and Manuals. This, as mentioned in a previous section of this chapter, is very important to the overall program. During this task, a manual will be developed defining the proper QA/QC procedures to be used throughout the monitoring program.

- Development of the Monitoring Data Base and Management System. This activity is concerned will the establishment of a comprehensive data base which will be used to store and analyze data throughout the program.

- Installation & Checkout of Monitoring Equipment/Systems. Upon procurement of the environmental monitoring equipment, stations will be installed for the collection of baseline evironmental data. Equipment will be installed and checked out to insure that everything is in working order. It should be noted that if possible this activity will take place as soon as the equipment is obtained and not necessarily according to the schedule presented in Figure 3-3.

- Field Monitoring, Laboratory Analysis, Data Collection, and Evaluation. Upon completion of the installation/checkout of the monitoring equipment and the training of the personnel, the monitoring program will be initiated. Progress

reports will be prepared on a quarterly basis with the first report being completed at the end of FY 1987.

- First Year QA/QC Review. QA/QC will be implemented throughout the monitoring program.

A recommended program schedule is outlined in Figure 3-3. However, the schedule is flexible enough to allow for changes should unforeseen problems occur which could adversely effect the entire program.

4.0 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES

During Fiscal Year 1986, CERT has identified and preliminarily characterized the major elements necessary to perform systematic risk assessments associated with a proposed high-level nuclear waste repository program located at Hanford Site, Washington (CERT, 1986). As a framework for this systematic risk assessment methodology, there are the two major categories of possible release scenarios: i.e., (1) transportation of high-level nuclear waste via highway, rail, or barge through the CTUIR possessory and usage rights area and (2) site preparation, construction, operation, closure and permanent storage of the radioactive waste at that designated permanent repository location.

The preliminary development of the risk assessment methodology was performed for the CTUIR High-Level Nuclear Waste Program in Fiscal Year 1986 (CERT, 1986) and will be applicable to the assessment of potential environmental and human health impacts within the CTUIR study area as well. The major elements comprising the preliminary tribal risk assessment methodology are: (1) characterization of scenarios for the potential release of contaminants to the natural environment, (2) characterization of the environmental dose to predesignated receptor locations principally by means of either atmospheric or hydrologic dispersion and transport of the contaminant from the point of release, (3) characterization of the human dose at specified receptor locations in terms of individual human health effects, and (4) conceptualization of a system for classifying and ranking those human health effects for each contaminant release scenario.

Since the potential exists within the proposed high-level nuclear waste repository program for significant releases of both radioactive and non-radioactive contaminants, major emphasis has been placed on the development of a risk assessment methodology that primarily addresses the potential radiological implications of possible contaminant releases. However, the foregoing structured approach would be also readily adaptable to other types of hazardous non-radioactive contaminants as well.

The major program emphasis in Fiscal Year 1987 will be placed upon (1) detailed development of specific scenarios for the potential release of radioactive contaminants that could deleteriously impact the CTUIR study area and (2) computerized implementation of a systematic risk assessment methodology based upon characteriza-

tion of the procedural elements (2), (3), and (4) as previously outlined in the preceding text and developed by CERT in Fiscal Year 1986.

4.1 RELEASE SCENARIO DEVELOPMENT AND ANALYSIS

Containment release scenarios will be developed for the two major categories of possible release of radioactive contaminants to the CTUIR possessory and usage rights area as illustrated in Maps 1 through 4.

4.1.1 Transportation Release Scenarios

Releases of radioactivity as a consequence of shipments of high-level nuclear waste to an underground repository at the Hanford Site are of major concern to the CTUIR. Both primary highway and railway routes to the Hanford Site pass directly through the Umatilla Reservation as shown in Maps 2, 3, and 4. Therefore, potential transportation release scenarios must be comprehensively investigated as cited in the CTUIR Scoping Study (CERT, 1984) and, more recently, in the preliminary development of a tribal risk assessment methodology (CERT, 1986).

Potential release scenarios can be further subdivided into two broad classes: (1) releases due to a normal, orderly sequence of operations along the specific transportation artery extending from the interim storage facility site (nuclear power plant facilities complex, MRS, FIS, reprocessing plant, etc.) to the proposed permanent, underground repository location at Hanford, and, (2) release scenarios arising from accidents occurring on tribal lands during high-level nuclear waste shipments along these same transportation routes.

Radioactive release scenarios arising from a normal or routine sequence of events during the shipments of nuclear wastes to the permanent respository are the easiest to define and characterize since these releases are primarily time dependent functions of the direct radiation dose criteria utilized in the design of the shipping cask or containers.

Since the Department of Transportation (DOT) regulations, found in 49 C.F.R., Section 173.441, set radiation level limitations for any shipment of radioactive materials, the

radiologial consequences of normal (incident-free) shipments of high-level nuclear-waste shipments through tribal lands is highly unlikely to result in excessive radiation doses to either the tribal nautral environment or population.

4.1.2 Transportation Accident Release Scenarios

Based on prior high-level nuclear waste shipping experience and continuing studies of new shipping cask or container designs and related risks and safety, it is believed that the overall transportation risks to public health and safety and the environment are quite low. However, perturbations to the present statistical data base as a consequence of the large number of shipments anticipated when the first permanent repository is selected must be factored into the development of contaminant release scenarios risk assessment methodologies.

The potential for high-level nuclear waste accidents on a national scale is roughly proportional to the shipping distances, transportation conditions, and the safety features incorporated into shipping casks and carrier equipment. The probability of accidents at any given geographic location are related to the transportation mode, the equipment design, operating regulations, the number and frequency of shipments, conditions of regional and local transportation corridors, weather and geologic hazards, and other related parameters.

Each transportation mode could result in potential radioactive exposure as a point source (at one location) or a line source (over an area between two points) of radiation. The accident scenarios which would result in a point or line source release via each transportation mode are as follows: collision or damage to the transit vehicle (a) with, or (b) without explosion; (1) with immediate release of (a) all or (b) part of the radioactive cargo (point source), or (2) with release of the cargo occurring over a distance and period of time (line source). These possibilities are diagrammed in Figure 4-1. Each type of release could result in radioactive dispersion to air, water, or ground surface.

Since both major truck and rail transportation routes currently proposed for high-level nuclear waste shipments to the Hanford Site pass through the Umatilla Reservation and the CTUIR ceded lands, potential release scenarios resulting in possible environmental and health impacts from potential transportation accidents will be developed for the CTUIR environmental surveillance program during Fiscal Year 1987.

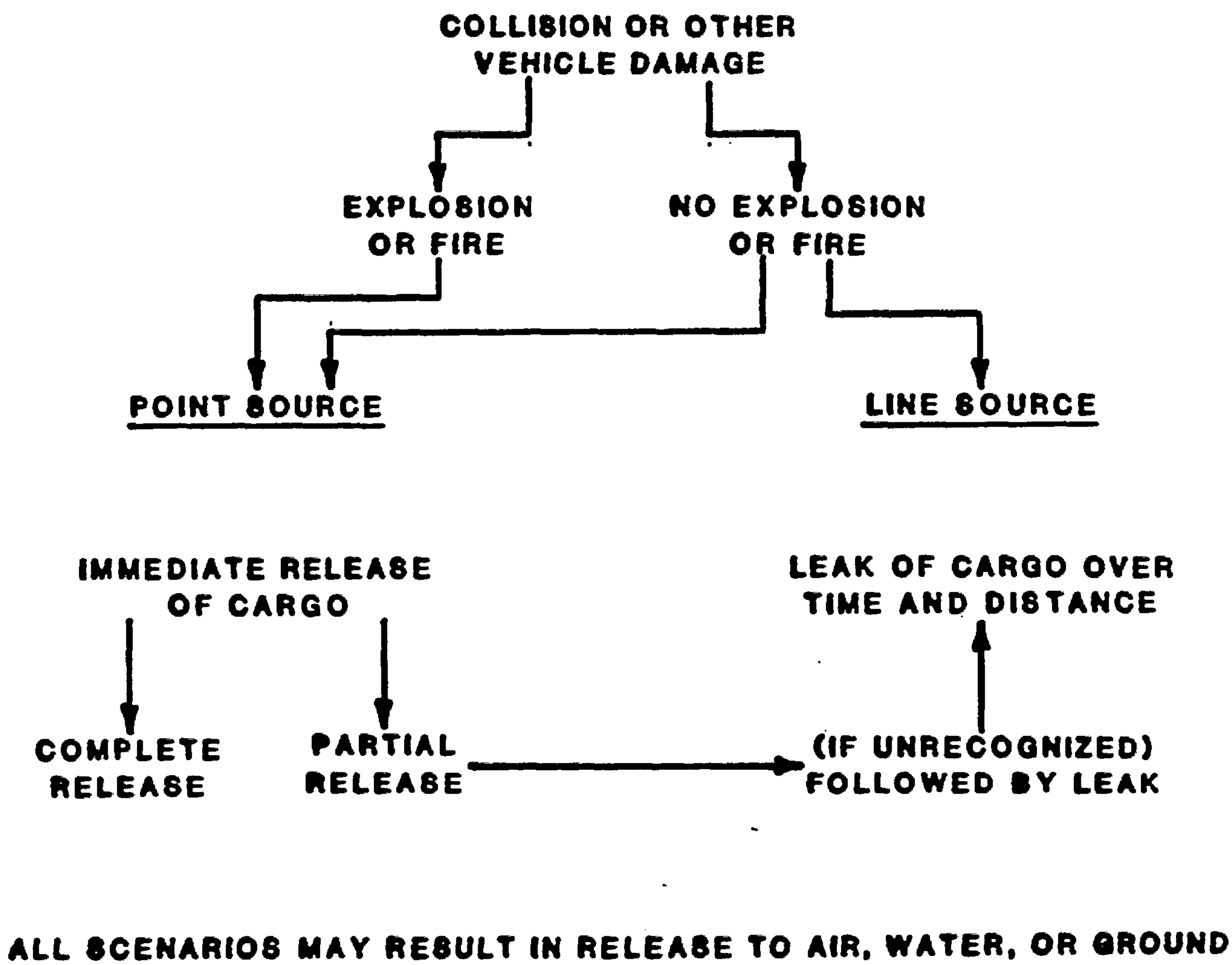


Figure 4-1. TRANSPORTATION RELEASE SCENARIOS

Candidate transportation accident release scenarios will be sequentially synthesized for both the aforementioned high-level nuclear waste shipment modes. Selected candidate release scenarios will then be evaluated utilizing the aforementioned mathematical risk assessment techniques characterized by CERT during Fiscal Year 1986 (CERT, 1986).

4.1.3 Repository Related Release Scenarios

Many different physical processes can affect the future behavior of an underground high-level nuclear waste repository. Detailed analysis and evaluation of these processes is necessary in order to develop pragmatic scenarios that could lead to significant releases of radioactive waste materials to the biosphere.

For purposes of selecting disruptive, release scenarios for detailed parametric characterization and subsequent release-risk assessment, a sequential process or method of analysis must be developed for the repository program. In terms of the characterization of credible release scenarios for the high-level nuclear waste repository in basalt, the process will entail a minimum of four major procedural steps as follows:

(1) Develop a comprehensive list of credible site-specific disruptive processes and events to the prescribed nominal or baseline conditions for the high-level nuclear waste repository.

(2) Adopt selection criteria by which disruptive release scenarios can be systematically identified for more detailed analysis.

(3) Assess the occurrence probability and likely adversity of the consequences of potential disruptive release scenarios.

(4) Select scenarios to be characterized sufficiently for use in a risk-consequence analysis.

Analysis of potential disruptions, changes, or differences from nominal repository design conditions encompasses four general classes of possible release scenarios:

(1) Uncertainties and potential omissions of significant consequence associated with characterization of the candidate repository site.

(2) Potential disruptions due to natural system dynamics within the general area encompassing the candidate repository site.

(3) Potential disruptive release scenarios resulting from repository construction and operations.

(4) Potential disruptive release scenarios induced by human activities other than repository construction and operation.

Each of the foregoing general classes of possible repository release scenarios will be briefly outlined.

4.1.3.1 Site Characterization and Uncertainties No candidate site can be characterized to 100 percent certainty. Reduction of all geologic and hydrologic characterization uncertainties to exceeding low values by extensive subsurface exploration in the basalt host rock will be unquestionably costly and may intrinsically reduce host rock isolation capability during the test program. The assessment of potential repository site characterization omissions and uncertainties, as used in this report, is in terms of probability of occurrence and potential adversity of consequences. While it is recognized that site characterization omissions and uncertainties do not represent changes or disruptions to actual site conditions, they have been included in the proposed development of potential release scenarios because they constitute conditions that could be omitted in the site characterization planning process.

4.1.3.2 Natural Systems Dynamics. Assessment of natural phenomena is largely dependent on work in the earth sciences. The various tasks entail both a description of the physical phenomena process and an evaluation of its likelihood of occurring in the future. Such work is at the very forefront of current research in the geologic sciences. A generic list of natural phenomena that could possibly lead to disruptive, radioactive release scenarios for any geologic, high-level nuclear waste repository is presented in Table 4-1. Although prediction of many events that occur on geologic time scales is beyond current capabilities, trends and ranges in behavior can often be determined.

Table 4-1. GENERIC LIST OF NATURAL PHENOMENA THAT COULD LEAD TO POTENTIALLY DISRUPTIVE RELEASE SCENARIOS FOR A SUBSURFACE HIGH-LEVEL NUCLEAR WASTE REPOSITORY

- Climatic fluctations
- Glaciation
- Denudation and stream erosion
- Magmatic activity
  - Extrusive
  - Intrusive
- Epeirogenic displacement
  - Igneous emplacement
  - Isostacy
- Orogenic diastrophism
  - Near-field faulting
  - Far-field faulting
  - Diapirism
  - Diagenesis
- Static fracturing
  - Surficial fissuring
  - Impact fracturing
  - Hydraulic fracturing
- Dissolutioning
- Sedimentation
- Flooding
- Undetected features
  - Faults, shear zones
  - Breccia pipes
  - Lava tubes
  - Gas or brine pockets
- Meteorites

4.1.3.3 Repository-Induced Disruptions. Another major category of processes affecting waste disposal in a subsurface high-level nuclear waste repository is the waste- and repository-induced phenomena. High level nuclear waste emits considerable amounts of radiation and heat. The presence of the mined excavation affects the surrounding host rock mechanically and could modify the groundwater hydrology. The most localized effects involve interactions between the waste package and the immediately surrounding rock. The behaviour of the back-filled mine and connecting shafts might also be modified. The largest-scale effects are principally those due to the effect of heat from the buried wste on the surrounding rock masses. Thus, the thermal output of the waste is important in several ways: It could lead to expansion of the rock mass leading to fracturing, it could locally increase rock permeability, and it could result in convection in groundwater. A generic list of waste and repository-induced phenomena is presented in Table 4-2.

Given knowledge of potential disruptions induced by construction or operations of the repository and analysis of the likely resultant consequences, the repository will be designed, if economically feasible, to mitigate such consequences. Repository-induced disruptions of the containment system cannot be categorized according to occurrence probability evaluations based upon extrapolating past occurrences of geologic events or processes into the future. Such decisions must be made on the basis of best-judgment consensus of occurrences probability as indicated by past construction and engineering design experience. Performance of underground facilities under various conditions will be assessed in progressively more detail as the repository design information becomes available.

4.1.3.4 Disruptions Resulting from Human Activities Independent of Repository Construction and Operation. The major category of processes and events affecting waste disposal in a subsurface, high-level nuclear waste repository that is the least amenable to scientific and engineering analysis relates to human-induced phenomena. Predictions of future activities by man are by their very nature entirely speculative. Specific investigations conducted to date in this area are quite limited (CERT, 1986).

Nevertheless, identification and further categorization of credible events and processes resulting from human activities independent of repository construction and operation are governed principally by four general guidelines established by the Nuclear Regulatory

Table 4-2. GENERIC LIST OF WASTE AND REPOSITORY-INDUCED PHENOMENA THAT COULD LEAD TO POTENTIALLY DISRUPTIVE RELEASE SCENARIOS FOR A SUBSURFACE HIGH-LEVEL NUCLEAR WASTE REPOSITORY

- Thermal effects
  - Differential elastic response
  - Nonelastic response
  - Fluid pressure changes
  - Local fluid migration
  - Canister migration
  - Convection
- Chemical effects
  - Geochemical alterations
  - Corrosion
  - Waste package-geology interactions
  - Gas generation
  - Seal-rock interactions
- Mechanical effects
  - Change in local state of stress
  - Readjustment of rock along joints
  - Local fracturing
  - Canister movement
  - Subsidence
- Radiation effects
  - Material property changes
  - Radiolysis
  - Criticality
  - Decay product gas generation
  - Stored energy
- Modification of hydrologic regime

Commission (NRC, 1982). Given these four guidelines, human intrusion would be either prohibited during the time that the consequences of such intrusion would be relatively significant, or a future generation would be prepared to accept the risks of intentional intrustion. A generic list of human-induced phenomena is given in Table 4-3. It should be noted that Table 4-3 includes possible disruptions from human activities both dependent and independent of repository construction and operation.

4.1.3.5 Planned Fiscal Year 1987 Repository Release Scenario Development. Given the four classes or categories of possible repository release scenarios outlined in Sections 4.1.3.1 through 4.1.3.4, candidate repository release scenarios will be developed to evaluate events, conditions, and processes (previously listed in a generic context in Tables 4-1, 4-2, and 4-3.) that are of practical concern for the permanent repository should it be located at the proposed Hanford Site. The basis for the systematic development of repository release scenarios will be, of necessity, the federal regulatory guidelines, standards, rules, and procedures for management and disposal of spent nuclear fuel, high-level, and transuranic radioactive wastes. The final standards (40 CFR 191) were promulgated by the U.S. Environmental Protection Agency (EPA) on September 1985. The Nuclear Regulatory Commission (NRC) previously published its final rule for 10 CFR, Part 60, on June 21, 1983, establishing technical criteria for disposal of high-level radioactive wastes in geologic repositories as required by the Nuclear Waste Policy Act of 1982.

On the basis of the preliminary investigations performed in Fiscal Year 1986, it is concluded that potential release scenarios for the long-term, permanent high-level nuclear waste repository have only been preliminarily characterized at the present time for the aforementioned four general classes of possible repository release scenarios.

Presumably, most of the uncertainties and potential omissions of significant consequences associated with site characterization will not be eliminated in the immediate future due to delays in the substantial DOE program planned for initiation at the Hanford Site in Fiscal Year 1987.

Table 4-3. GENERIC LIST OF HUMAN-INDUCED PHENOMENA THAT COULD LEAD TO POTENTIALLY DISRUPTIVE RELEASE SCENARIOS FOR A SUBSURFACE HIGH-LEVEL NUCLEAR WASTE REPOSITORY

- Improper design or operation
  - Shaft seal failure
  - Improper waste emplacement
- Undetected past intrusion
  - Undiscovered boreholes
  - Mine shafts
- Inadvertent future intrusion
  - Archaeological exhumation
  - Weapons testing
  - Non-nuclear waste disposal
  - Resource mining (salt, mineral, hydrocarbon, geothermal)
  - Storage of hydrocarbons, compressed air, or hot water
- Intentional intrusion
  - War
  - Sabotage
  - Waste recovery
- Perturbation of groundwater system
  - Irrigation
- Reservoirs
- Intentinal artificial groundwater recharge or withdrawal
- Chemical liquid waste disposal
- Biosphere alteration
  - Establishment of population center
  - Climate modification

As previously mentioned, only preliminary conceptual designs of the underground repository at the proposed Hanford Site have been released officially by DOE and its subcontractors. Therefore, more detailed characterization of repository construction and operation must await the release by DOE of more detailed design information in order to develop practical, sequential event trees for repository release scenarios within this class of possible release scenarios.

Therefore, it is recommended that near-term efforts within the tribal programs for the characterization of candidate repository release scenarios be centered on the development of those candidate scenarios arising from disruptions associated with regional and area natural systems dynamics and/or potentially disruptive scenarios induced by human activities other than repository construction and operation. It is further suggested that the probabilities for combinatory scenarios of the two foregoing classes of disruptive releases also be investigated in greater detail during the planned Fiscal Year 1987 task activities.

Potential disruptive related release scenarios created by natural or man-made geologic phenomena that are planned for more detailed investigations during Fiscal Year 1987 include the following:

The probability of disruption of a deep, high-level nuclear waste repository by natural or man-made geologic phenomena has been studied by DOE and its contractors. These phenomena could include:

(1) Seismicity—natural or human-induced (e.g., reservoir-induced, deep injection well-induced, etc.);

(2) Faulting—direct displacement of the repository, unrelated to seismicity; and

(3) Volcanism—breaching or flooding of the repository due to volcanic activity.

In addition, more detailed investigations of potential repository release scenarios caused by flooding will be investigated.

Of all the natural catastrophic events that could adversely affect a radioactive waste facility constructed within the Pasco Basin, flooding is the most probable, although not

necessarily the most damaging. Flooding presents the greatest risk to a subsurface repository during the so-called operating phase, which is the period following construction and prior to permanent closure and sealing (Leonhart, 1979).

To analyze possible release scenarios caused by flooding, the following types of floods that have some probability of occurring in the Hanford area will be considered as potential release mechanisms:

(1) Floods on the Columbia River—caused by precipitation;

(2) Grand Coulee dam breach—natural or man-made;

3) Cold Creek flash flood—caused by a Probable Maximum Precipitation (PMP) event

(4) Catastrophic flood—caused by renewal of glaciation; and

(5) Reservoir-induced water-table rise—due to new dam construction.

4.2 IMPLEMENTATION OF RISK ASSESSMENT METHODOLOGIES

Once a set of release scenarios has been systematically developed and characterized for the two major classes of releases; i.e., (1) those associated with the high-level nuclear waste transportation system, and (2) those related to the construction, operation, permanent closure, and long-term waste storage of the proposed subsurface geologic repository, the transport of both radiological and non-radiological pollutants to the surrounding natural environment becomes a major consideration in the development of an overall methodology to assess potential risks.

Since all the basic radiation standards currently promulgated are given in terms of a radiation dose to people, the environmental program planning process must address predictive mathematical modeling of critical environmental pathways which may contribute to the radiation exposure to the tribal environment and the human population.

In this regard, atmospheric release and subsequent transport are presently envisioned as being the most lil:ely major category of disruptive accident scenarios resulting from the operation of a high-level nuclear waste transportation system. Similarly, it is generally agreed that the most likely pathway by which wastes could be released from a subsurface geologic repository is transport to the surface by groundwater. Therefore, various atmospheric and hydrologic dispersion models either presently being planned, under current research and development, or being actively utilized to predict environmental concentrations and human doses have been evaluated for possible implementation in the overall risk assessment methodology currently under development for the tribal high-level nuclear waste repository program (CERT, 1986). It is contended that the above approach should be more effective in terms of both development time and cost for this element of the overall composite of mathematical modeling techniques that should ultimately comprise the risk assessment methodology for detailed analysis of the most likely disruptive release scenarios that could deleteriously impact tribal possessory and usage rights areas.

4.2.1 Implementation of Risk Assessment Methodologies for Transportation Release Scenarios.

Since the probability of viable contaminant release scenarios resulting from high-level nuclear waste shipment accidents either on or adjacent to the CTUIR study area is a major concern to the Umatilla Tribe, the implementation of a risk assessment methodology to utilize for this category of potential release scenario is planned for FY 1987.

4.2.1.1 RADTRAN II Transportation Risk Assessment Computer Model. The RADTRAN II computer model can be utilized to evaluate radiological risk from transportation accident release scenarios as illustrated in Figure 4-2. Although Figure 4-2 implies that RADTRAN II accommodates atmospheric dispersion to the natural environment from the point of contaminant release from a transportaton accident scenario, such is not the case. Airborne material dispersal from the accident site is a function of the prevailing meteorological conditions. Generally, these conditions can be described in terms of time-integrated atmospheric dilution factors (Curies-sec/m^3) as a function of area within an isopleth contour on which it applies. In RADTRAN II, the user must specify a set of integrated concentration values and corresponding areas which have been computed

assuming a totally reflective lower boundary. The code then calculates a set of airborne concentration and deposition contours out to a maximum area of $10^9 m^2$. Thus, in most practical situations, the analyst must utilize an atmospheric dispersion model to develop the dispersion characteristics of the contaminant release in any event. Therefore, it is planned to utilize the RADTRAN II code in conjunction with a sequential fault or event-tree model to derive the specific mechanisms for contaminant release. An adequate dispersion and transport model; e.g., EPA-AIRDOS or KRONIC, will then be utilized to predict the appropriate downwind radionuclide concentrations and human radiation dose at specific receptor locations. Both the EPA-AIRDOS and KRONIC computer codes have dosimetric models to assess both external and internal radiation doses to critical organs of the human body. However, neither of the above codes presently will accommodate atmospheric contaminant transport in complex terrain which is quite commonplace within the CTUIR study area. Therefore, uncertainties in the predicted results using the foregoing models must be evaluated in those instances where complex terrain is an important consideration.

The RADTRAN computer code also can be utilized to evaluate human health effects in terms of stochastic effects as prescribed by current federal regulatory standards and guidelines. Optionally, non-stochastic human health effects can also be evaluated by implementation of a model developed for the tribal risk assessment methodology during Fiscal Year 1986 (CERT, 1986).

Computerized implementation of the system for classifying and ranking potential human health effects on the basis of each potential release scenario, also developed during the Fiscal Year 1986 program, will then be utilized to make comparisons within and among various scenarios of possible contaminant releases. The proposed system segregates the health effects information into a probability/consequence (PXC) index. The PXC index is, therefore, the cross-product of the probability of occurrence of a specific release scenario and the excess cases generated by each scenario. Thus, the PXC index allows a composite weighting of two factors such that a high probability/low consequence scenario can be ranked equally, for example, with a low probability/high consequence scenario. Therefore, PXC indices for each effect will be developed to rank effects within a scenario and to make comparisons among arrays of scenarios.

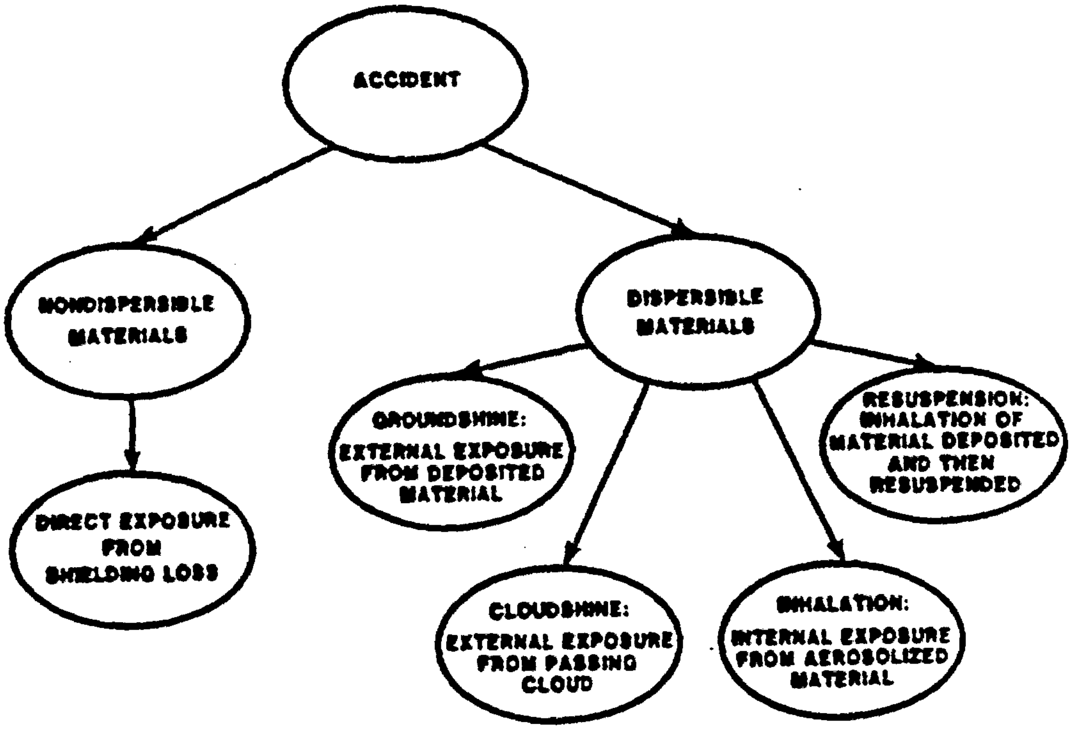


Figure 4-2. RADTRAN II COMPUTER MODEL FLOW CHART: TRANSPORTATION ACCIDENT RELEASE—ATMOSPHERIC DISPERSION

4.2.2 Implementation of Risk Assessment Methodologies for Repository-Related Release Scenarios

Since it is generally recognized that the most probable mode by which radioactive contaminants could be released from an underground geologic repository facility located at the Hanford Site is through the groundwater system, the principal objectives of long-term (10,000 years or more) repository performance assessment are to quantify the degree of high-level nuclear waste isolation achieved by the repository system; i.e., the engineered systems and the geologic medium. The basic set of system performance measures that will be used to quantify system performance will consist of the following: (1) groundwater flow paths and travel times from the repository to the accessible environment, (2) the rate of radionuclide release from the repository system, and (3), the total activity (of individual radionuclides) leaving the boundaries of a specified control or buffer zone around the repository as illustrated in Figure 4-3.

One of the fundamental objectives of the long-term repository performance assessment is to determine the potential flow paths from the proposed repository and to estimate the travel times along these pathways to the accessible environment. The accessible environment is defined in the EPA environmental standards (40 CFR, Part 191) as "(1) the atmosphere, (2) land surfaces, (3) surface waters, (4) oceans, and (5) all of the lithosphere that is beyond the controlled area." The controlled area illustrated in Figure 4-3 is also defined as (1) a surface location to be identified by passive institutional controls, that encompasses no more than 100 square kilometers and extends horizontally no more than five kilometers in any direction from the outer boundary of the original location of the radioactive wastes in a disposal system, and (2) the surface underlying such a surface location.

Hydrologic conditions generally considered favorable for waste isolation are long flow paths to the accessible environment, which are confined to the deep formations, and with travel times ranging from several thousands to hundreds of thousands of years. A minimum groundwater transit time of at least 1,000 years to the accessible environment is a current technical criterion proposed by the USNRC. Thus, one of the foremost repository performance issues is to determine whether the pre-waste emplacement groundwater travel times near the repository are sufficient to assure compliance with both technical and regulatory criteria.

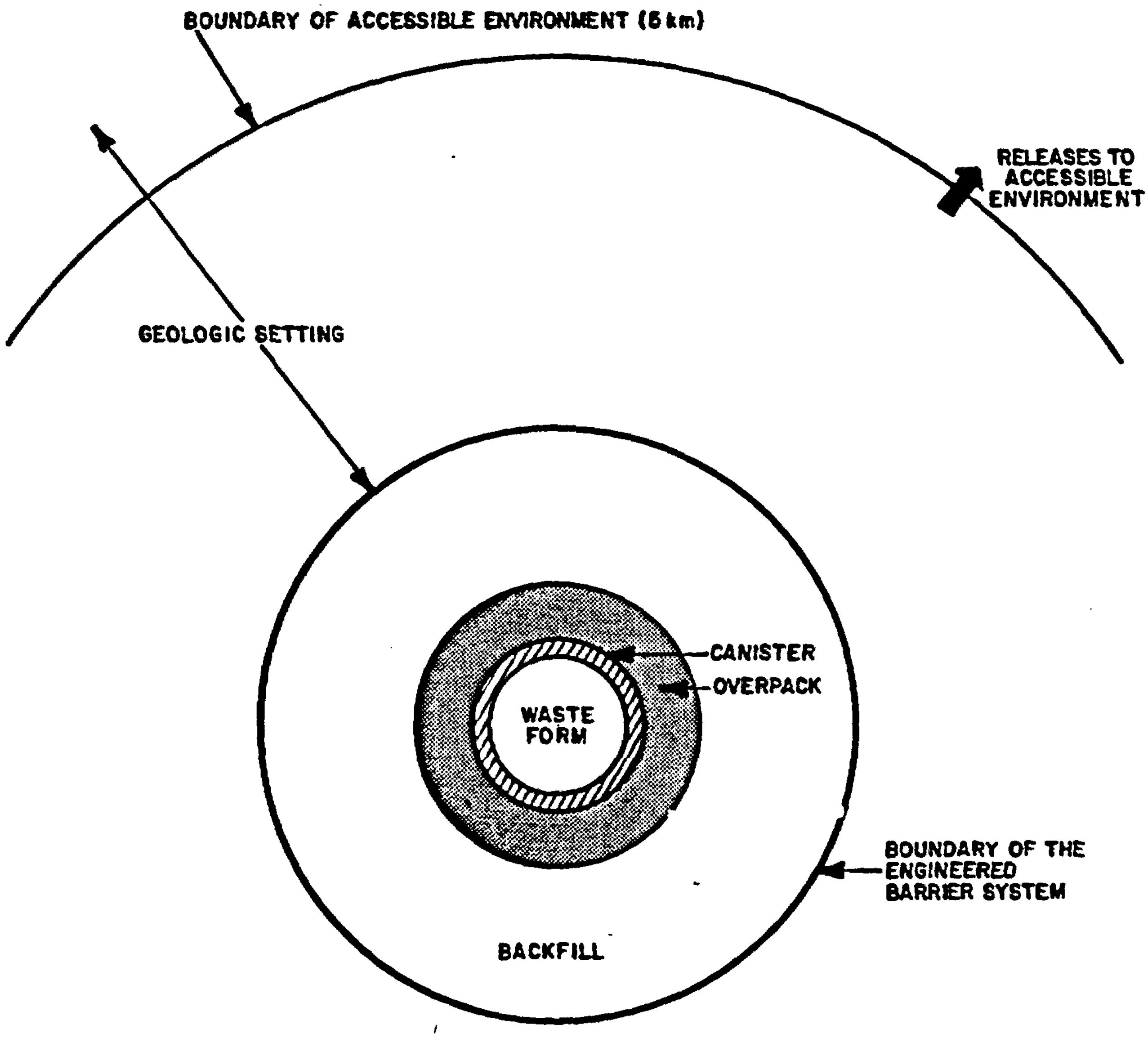


Figure 4-3. CONCEPTUAL DIAGRAM OF REPOSITORY SYSTEM AND REGULATORY CRITERIA.

Although many factors determine the degree of long-term waste isolation achieved by the repository system, the basic factors are (1) the containment period provided by the engineered system including the waste package and the underground facility and (2) the rate of radionuclide release from the emplacement horizon. The initial containment period (i.e., time period during which the nuclear wastes are confined to the engineered system) following repository closure is important because it mitigates any processes or events induced by the repository environment that adversely affect long-term waste isolation. After the containment period, it is assumed that any potential release will be controlled by the engineered barriers in the underground facility and the primary geologic barrier (i.e., emplacement horizon).

The long-term radionuclide release rate will be affected by the hydrologic and geochemical characteristics of the emplacement horizon; however, the period of containment depends on the engineered barriers and waste package designs. Thus, another significant repository performance issue relates to whether the very near-field interaction between the waste package and its components, the undergound facility and the geologic setting in basalt compromise waste package or engineered system performance.

To address this issue, predictive models for radionuclide hydrologic transport which take into account waste package degradation, waste from leaching, groundwater flow, and thermal conditions in the fractured, porous rock, must be applied to estimate the release rates and mass fluxes for a set of key radionuclides (Barney and Wood, 1980). Predictive estimates of these quantities of contaminant release and their variations over the entire waste isolation period as currently envisioned must be obtained for both the normal or controlled repository conditions and geologic setting as well as the off-normal or disruptive release scenarios which have been previously discussed.

The aforementioned 5-kilometer control zone promulgated by EPA's 40 CFR 191 regulatory standard and previously shown in Figure 4-3, sets the numerical limits on the allowable quantities of radionuclides released to the biosphere. Since the EPA regulatory standards also limit the quantity of radionuclides released over a 10,000 year period, another repository performance issue becomes the assessment of the total amount of radioactive contaminants potentially releasable to the accessible environment in a 10,000 year period as a consequence of credible normal and/or accident repository release scenarios. Beyond the 10,000-year time period, it is presumed that the radiological risk

of the high-level nuclear waste is at an acceptable level because of the reduction of toxicity by decay and/or dilution. Longer time frames may be considered, however, for selected cases.

Since the amount of radionuclides leaving the designated buffer zone will depend on the repository release rates, groundwater flow paths, and travel times, the resolution of this important issue hinges on the degree to which the first two issues are resolved.

As indicated in the EPA 40CFR 191 regulatory standard, a satisfactory resolution of this issue will require a comprehensive long-term risk assessment that: (1) identifies the plausible release modes, (2) estimates the probabilities of each release mode, and (3) conservatively bounds the consequences of releases. As part of the planned tribal performance assessment, a relatively large number of hydrologic simulations, considering a broad range of conditions, probably will be required to provide sufficient assurance that the model predictions compensate for uncertainties and, thereby, give a reasonable expectation of compliance with the EPA regulatory standard.

In the first stage of long-term repository performance analysis, the objective is to identify the geotechnical factors and physical processes that have the most significant impact on containment and degree of isolation. Moreover, a quantitative understanding of the cause-and-effect relationships is developed between the potential release initiating events/processes and the rate of release. With this information, the consequences of radionuclide release and movement through the groundwater can be predicted to quantify long-term performance of the repository system. Because of the inherent uncertainties in such predictions, a conservative consequence analysis is required that is based on the use of both deterministic and probabilistic models. These consequence analyses should provide the information needed to quantify the likelihood of compliance with applicable criteria and regulations. Applying this approach to the set of release scenarios quantifies the radiologic risk of the repository system.

Because of the complexity of the processes, the overall long-term performance analysis problem must be broken down to one of analyzing the hydrologic processes in three subregions. These are very near field (canister to room scale), near field (repository scale), and far field (basinwide scale). By this approach, mathematical models for each subregion can be developed that realistically portray the dominant physical processes, while accounting for less important processes in an approximate manner.

A typical consequence analysis approach that can be used to address the repository long-term performance analysis issues is presented in Figure 4-4. The individual modeling approaches are designed to analyze the set of processes relevant to specific performance analysis issues. The very near-field and far-field models provide information needed for the near-field models, such as boundary conditions and source terms, whereas the near-field models provide flow paths starting locations for the far-field models.

Recognizing that the future decisions regarding the repository site will place much reliance on model predictions, consideration of uncertain elements in the consequence analysis is of fundamental and key importance. For the most part,the uncertainty in model predictions can be attributed to four sources:

- limitations in the mathematical models, including the computer codes that describe hydrologic and transport processes,
- random and systematic errors in field measurements of hydrologic properties,
- errors arising from subjective interpretations of the spatial variations of hydrologic parameters from discrete data points, and
- incompleteness of geohydrologic characterization.

The first source of uncertainty, which may be termed model uncertainty, can be addressed, at least to a limited degree, by code benchmarking and verification and by comparing computer-based model simulations with experimental data. These results, in turn, can be analyzed to determine the degree of correlation between measurement and calculation. The other three sources, which represent data uncertainty, can be evaluated using a variety of approaches. Various statistical techniques are available that estimate the impact of uncertain elements, given a probabilistic description of the model input (i.e., a probability density function for each hydrologic parameter). The last two elements can also be grouped into a descriptive uncertainty category, which is perhaps the most difficult to analyze in a rigorous fashion. Kriging techniques (Delhomme, 1976; Doctor, 1979), used in combination with a systematic scenario analysis, will provide a pragmatic approach to developing continuous representations of hydrologic data with uncertainty bounds and evaluating hydrologic significance of possible undetected geologic features.

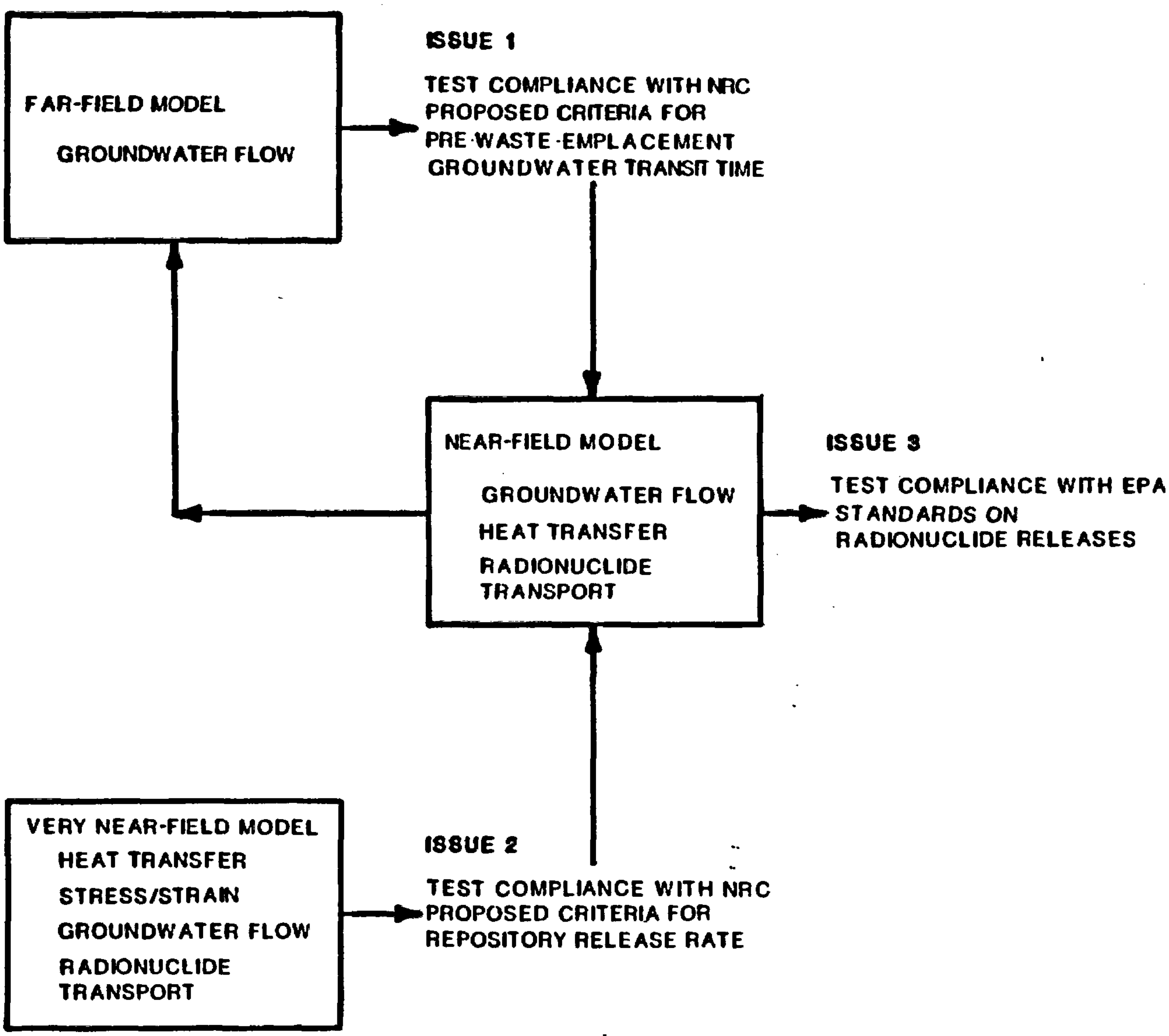


Figure 4-4. RELATIONSHIP BETWEEN PREDICTIVE MODELS AND PRIMARY LONG-TERM PERFORMANCE ASSESSMENT ISSUES

The large quantity of measured data required for a rigorous uncertainty analysis appears to be a major obstacle in applying this technique to diverse geohydrologic systems. This indication is further reinforced by the simple fact that characterization of a candidate site may be limited to assure that natural barriers are not disturbed or compromised. An alternate approach to the problem of addressing predictive uncertainty is to adopt a systematic and conservative methodology that compensates for uncertain elements in the consequence analysis without assuming conditions that are not credible. Such a methodology should provide a framework for guiding the system simulations so that bounding estimates of radionuclide migration are obtained.

4.2.2.1 Integrated Groundwater System Preliminary Computer Modeling Procedure - Proposed Hanford High-Level Nuclear Waste Repository Site. The principal computer codes either previously developed or currently under development for performance analysis of a repository in basalt have been reviewed during Fiscal Year 1986 for possible implementation within the framework of the tribal risk assessment methodology development. The vast majority of this large suite of computer codes was developed and applied as part of the earlier BWIP studies at the Hanford site. The primary computer codes currently being adapted to long-term geologic repository performance analysis are presented in Table 4-4.

Selected computer models presented in Table 4-4 can be integrated to produce a system model capable of effectively modeling the potential physical and chemical processes that can arise from the waste package environment through groundwater transport leading to environmental and human doses.

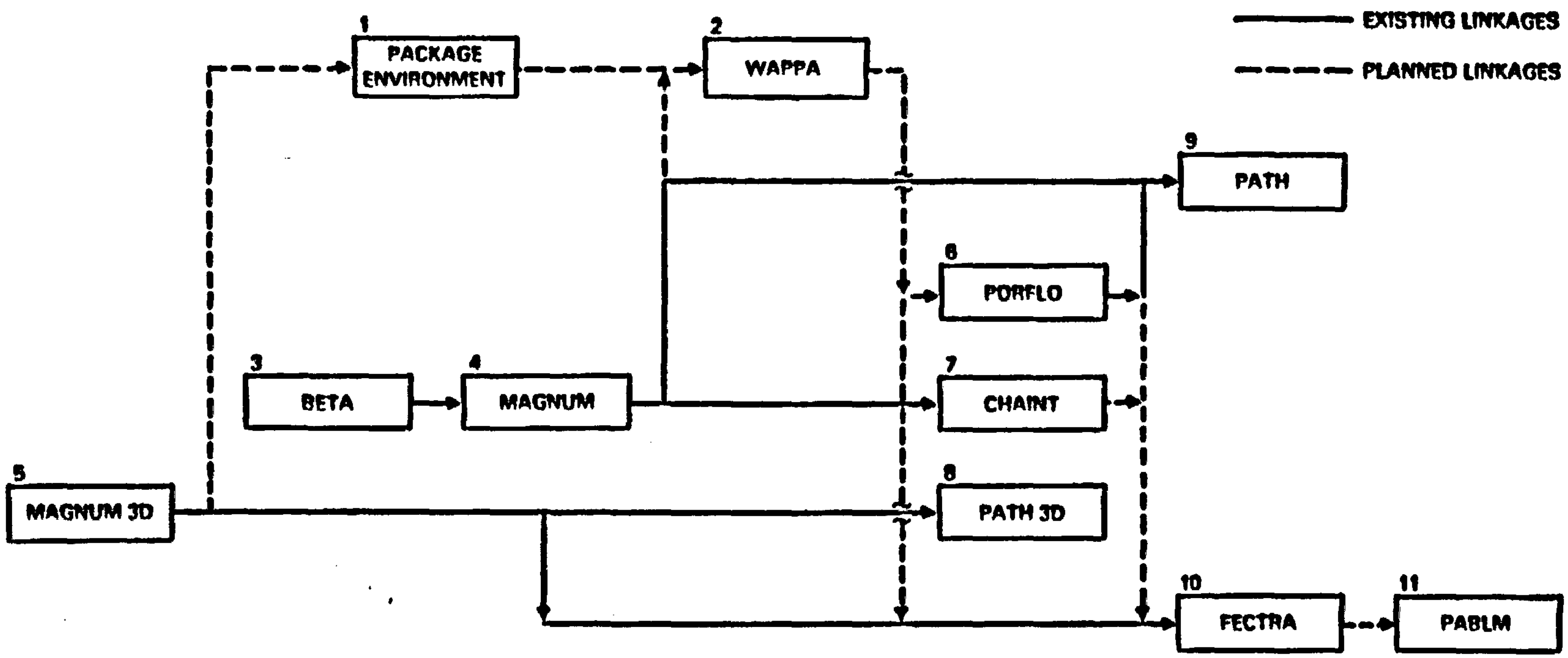
The interrelationships of the various subsystems computer models in a preliminary overall system model are conceptually presented in Figure 4-5. The computer codes presented in Figure 4-5 represent an integrated set of models specifically applicable to a repository system in basaltic rock. However, it must be emphasized that many unresolved uncertainties exist due to the current paucity of the experimental data base. Unless reliable boundary conditions and hydraulic parameters are determined during site characterization and until a defensible conceptual groundwater model is developed, little confidence can be attached from the results of any one—or a series of—computerized numerical codes.

Table 4-4. SUMMARY OF CURRENTLY-AVAILABLE CODES FOR UTILIZATION IN BASALT REPOSITORY PERFORMANCE ANALYSIS

Computer Code	Approach		Stress/ strain		Ground-water flow		Heat		Radionuclide transport			Computational method			
	CO	DC	LI	NL	IS	NI	AD	DS	S	MC	DE	FE	FD	AL	DI
Very Near Field															
BETA	X		X		X	X		X				X			2
DAMSWEL	X		X	X	X	X		X				X			2
ANSYS	X	X	X	X	X	X		X				X			3
HEATING6	X					X		X					X		3
MAGNUM 2D	X	X			X	X	X	X				X			2
CHAINT	X	X							X	X	X	X			2
BARIER[a]	X					X			X				X		1
WAPPA[a]	X					X			X				X		1
Near Field															
PORFLO	X				X	X	X	X	X				X		2
PATH[b]	X	X			X	X						X			2
MAGNUM	X	X			X	X	X	X				X			2
CHAINT	X	X							X	X	X	X			2
SWIFT	X				X	X	X	X	X	X	X		X		3
Far Field															
MAGNUM 3D	X				X							X			3
PATH 3D[b]	X				X							X			3
FECTRA	X								X			X			3
SWIFT	X				X	X	X	X	X	X	X		X		3
FE3DGW	X				X							X			3
WOOD/SALTER	X				X				X	X				X	1
NUTRAN	X								X	X				X	1

AD-Advectopm
AL-Analytical
CO-Continuum
DC-Discontinuum
DE-Decay Chains
DI-Dimensionality
DS-Diffusion
FD-Finite Difference
FE-Finite Element
IS-Isothermal
LI-Linear Properties
MC-Multicomponent
NI-Nonisothermal
NL-Nonlinear Properties
S-Single Component

[a] Codes currently under development.
[b] Computes pathlines, streamlines, and travel times.



1. WASTE PACKAGE ENVIRONMENT
2. RADIONUCLIDE RELEASE
3. FRACTURE ALTERATIONS
4. NEAR-FIELD AND VERY NEAR-FIELD GROUNDWATER FLOW FIELD
5. FAR-FIELD GROUNDWATER FLOW FIELD AND RESATURATION
6. NEAR-FIELD RADIONUCLIDE TRANSPORT
7. VERY NEAR-FIELD RADIONUCLIDE TRANSPORT
8. FAR-FIELD GROUNDWATER PATHLINES AND TRAVEL TIMES
9. NEAR-FIELD AND VERY NEAR-FIELD GROUNDWATER PATHLINES AND TRAVEL TIMES
10. FAR-FIELD RADIONUCLIDE TRANSPORT
11. DOSE TO MAN

RCP8209-122

Figure 4-5. PRELIMINARY GROUNDWATER SYSTEM MODELING FORMAT - HANFORD HIGH-LEVEL NUCLEAR WASTE REPOSITORY

Thus, it may be concluded that, as more definitive experimental data is developed during site characterization, the various computer-based subsystem models comprising the overall groundwater system analysis procedure could change appreciably from the preliminary format outlined in Figure 4-5. Therefore, implementation of an integrated groundwater modeling procedure for repository related release scenarios will be an evolutionary development process over the next several years.

As previously discussed in Section 4.2.1, mathematical models have been preliminarily developed for characterization of human health effects for computation of both stochastic and non-stochastic effects that could be coupled to the output of the human dosimetric model in a code such as PABLM (see Figure 4-5). Similarly, the preliminary system model for classifying and ranking human health effects on the basis of each release scenario could also be implemented into an intergrated groundwater modeling procedure for repository-related scenario risk assessment.

4.2.2.2 Surface Water Transport Modeling Considerations. The surface water transport of radioactive contaminants as estimated from possible release scenarios envisioned for a proposed high-level nuclear waste repository program being implemented at the Hanford Site could conceivably impact the natural environment of the CTUIR due to potential release scenarios from both major system categories; i.e., the transportation system and the repository storage system.

For example, radionuclide release from the repository could be transported intially by means of a groundwater pathway into an unconfined-surface aquifer in the accessible environment; e.g., a perched aquifer adjacent to a river or a stream. Thus,the radioactive contaminants upon reaching the river course could be subsequently transported by surface waters to the CTUIR study area via several hydrologic pathways as previously illustrated.

In contrast, a transportation system accident release scenario conceivably could occur where the radionuclides could be dispersed either directly into or near surface waters within the tribal possessory and usage rights area.

Nevertheless, several computer-based surface water modeling techniques reviewed and evaluated in Fiscal Year 1986 (CERT, 1986) should be amenable to implementation into the overall tribal risk assessment methodology with relatively minor revisions to existing, available surface water transport models.

4.3 TRIBAL ENVIRONMENTAL IMPACT ANALYSIS AND STUDIES - FISCAL YEAR 1987 PROGRAM SCHEDULES.

A preliminary assessment of potential environmental impacts to the CTUIR study area that are related to the proposed high-level nuclear waste repository program at Hanford Site, Washington will be performed. This assessment will entail the development of candidate release scenarios, computation of the contaminant dispersion to the tribal environment, assessment of the potential health risk to the tribal population and classification of health risk for each selected candidate release scenario.

Program activities will be initiated with the implementation and modification of selected, existing atmospheric and hydrologic dispersion and transport computer-based mathematical modeling techniques designed to investigate radioactive contaminant release scenarios that are necessary to adequately assess potential environmental impacts to the Umatilla and its possessory and usage rights area. An initial comparative screening evaluation of potentially significant scenarios for the release of radioactive contaminants to tribal lands will be performed for both major categories of release scenarios: (1) transportation of high-level nuclear waste through the CTUIR via highway or rail shipment modes and (2) construction, operation, closure, and permanent, long-term storage of high-level nuclear waste in a repository at the Hanford Site. Preliminary environmental radiation doses to tribal lands will be determined for all selected candidate release scenarios utilizing appropriate dispersion and transport modeling techniques previously described. Design and implementation of computer-based health risk mathematical models also will be developed within this task on the basis of risk assessment methodology development activities performed in Fiscal Year 1985 and Fiscal Year 1986. Subsequently, the health risks to the tribal population will be systematically classified and ranked on the basis of applicable regulatory standards for each selected release scenario by means of appropriate risk assessment mathematical modeling methodology. Figure 4-6 is a preliminary schedule outlining major activities and milestones. A final report will be prepared describing the results of this preliminary environmental impact assessment.

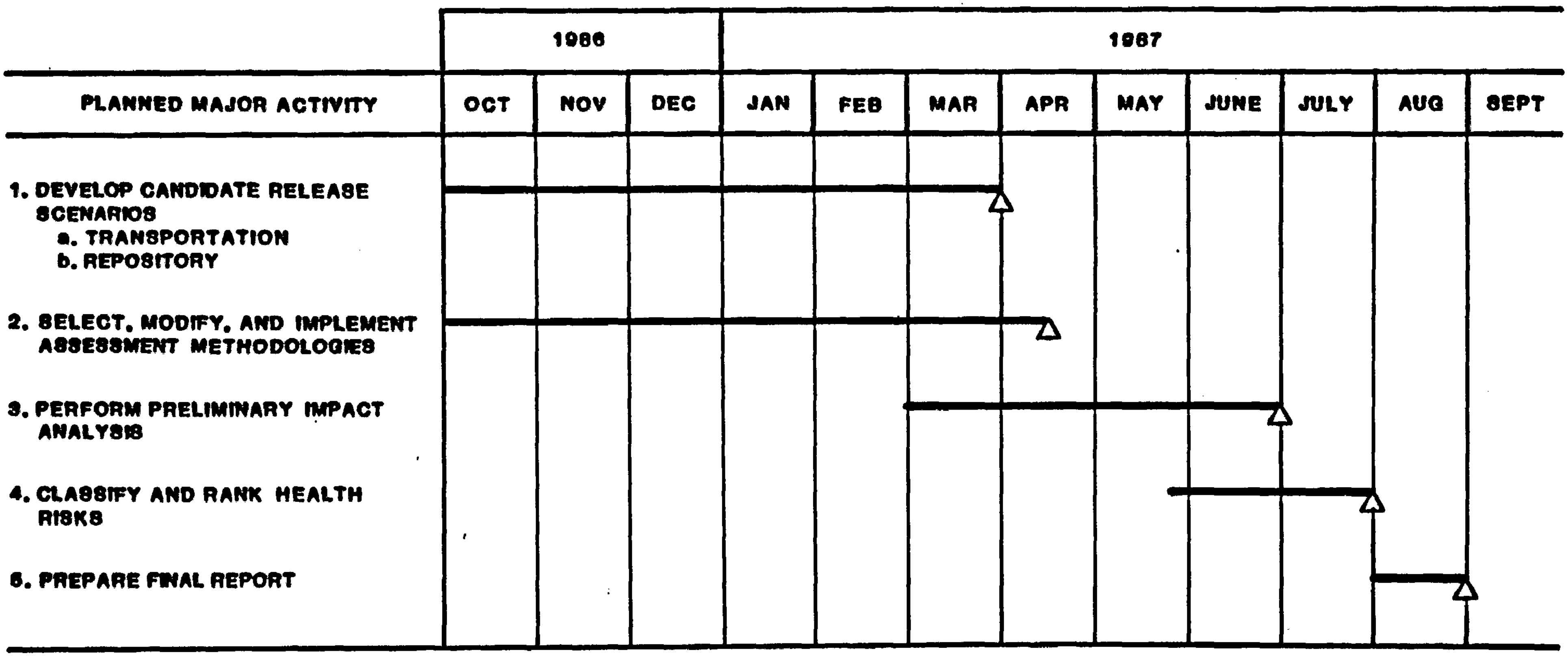


Figure 4-6. TRIBAL ENVIRONMENTAL IMPACT ANALYSIS AND STUDIES MAJOR PROGRAM ACTIVITIES SCHEDULES AND MILESTONES FOR FY 1987

REFERENCES

Council of Energy Resource Tribes, 1985. Nez Perce Tribe Scoping Study, Basalt Waste Isolation Project, Denver, Colorado.

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Gonthier, J.B. and Harris, D.D., 1977. Water Resources of the Umatilla Indian Reservation, Oregon, U.S.G.S. Water Resources Investigations 77-3, Washington, D.C.

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APPENDIX A

STATE AND FEDERAL ENVIRONMENTAL RADIATION MONITORING PROGRAMS

APPENDIX A

ENVIRONMENTAL RADIATION MONITORING PROGRAMS

State of Idaho

Idaho has no environmental radiation monitoring program.

State of Oregon (Partial listing)

Location	Type Measurement
La Grande	TLD, air filter, vegetation, water
McNary Dam	TLD, vegetation, ground water, Columbia River water
Dayville	TLD
Umatilla River	River water (3 miles south of Umatilla)
John Day	River water
Dalles Dam	River
Briggs Junction	Deschutes River water
Arlington	Ground water
Cedar Springs	Ground water

Pressurized ion chamber measurements are made once per year at selected locations.

State of Washington

Puget Sound	
Seattle - Smith Tower	Air filter
Seattle - Boeing Field	TLD
Cedar River	
Landsbert	Surface water
Puyallup River	
Puyallup	Surface water
Hood Canal	
Bangor	TLD, sediment, shellfish
PSNS Bremerton	Sediment
Olympia	TLD
Bremerton	TLD
Pack Forest	Ground water - 4 locations
Coastal Peninsula	
Elma	TLD
Southwest	
Vancouver	TLD
Castle Rock	TLD

APPENDIX A (continued)

State of Washington (continued)

Location	Type Measurement
Joy Mining Company	TLD (2 locations), surface water (2 locations), soil (2 locations), sediment (2 locations), ground water (3 locations), vegetation (1 location)

U.S. Environmental Protection Agency

Standby Air Surveillance and Milk Networks

Air Surveillance	Milk
Pocatello, ID Nampa, ID Mountain Home, ID	Lewiston, ID Boise, ID Twin Falls, ID Pocatello, ID
Medford, OR Burns, OR	Idaho Falls, ID Idaho Falls, ID Caldwell, ID
Seattle, WA Spokance, WA	Tillamook, OR Corvallis, OR Eugene, OR Redmond, OR Grants Pass, OR Medford, OR Klamath Falls, OR Portland, OR Milton-Freewater, OR Myrtle Point, OR
	Seattle, WA Moses Lake, WA Spokane, WA

Environmental Radiation Ambient Monitoring System

Location	Type Measurement
Boise, ID	Drinking water
Buhl, ID (Snake River)	Surface water
Idaho Falls, ID	Air filter, precipitation, drinking water, surface water, pasteurized milk
Portland, OR	Air filter, precipitation, drinking water, Krypton-85, pasteurized milk

APPENDIX A (continued)

US Environmental Protection Agency (continued)

Environmental Radiation Ambient Monitoring System (continued)

Location	Type Measurement
Westport, OR (Columbia River)	Surface water
Richland, WA (Columbia River)	Surface water, drinking water
Seattle, WA	Drinking water, pasteurized milk
Spokane, WA	Pasteurized milk

U.S. Department of Energy

Air Sampling Stations

Hanford Site	25 on-site stations, 15 perimeter stations
Othello	
Pasco	
Richland	
Benton City	
Moses Lake	
Washtucna	
Walla Walla	
McNary Dam	
Sunnyside	

Surface Water Stations

Hanford Site	4 on-site ponds
Columbia River	1 location upstream of Hanford Site 2 locations downstream of Hanford Site

Ground Water Monitoring Stations

Hanford Site	Approximately 300 on-site wells

TLD Stations

Hanford Site	7 on-site stations 16 perimeter stations
Benton City	
Othello	
Connell	
Pasco	
Richland	
Walla Walla	
McNary	
Sunnyside	
Moses Lake	
Washtucna	

APPENDIX A (continued)

U.S. Department of Energy (continued)

Soil and Vegetation Sampling Stations

Hanford Site	15 on-site stations
Riverview	
Byers Landing	
Sagemore	
Taylor Flats #2	Prosser Barricade
W. End Fir Road	ALE
Ringold	South of 300 Area
Berg Ranch	Benton City
Wahluke #2	Sunnyside
Vernita Bridge	
Yakima Barricade	
Rattlesnake Springs	

Milk Sampling Locations

Wahluke East Area Composite
Sagemore Area Composite
Riverview Area
Benton City Area
Sunnyside Area
Moses Lake Area

Food Sampling Locations

Wahluke East Area	Leafy vegetables, wheat
Riverview Area	Leafy vegetables, wheat, beef
Benton City Area	Leafy vegetables, wheat
Sunnyside Area	Leafy vegetables, fruit, wheat, chickens, eggs
Moses Lake Area	Leafy vegetables, wheat
Sagemore Area	Fruit, wheat, beef, chickens, eggs
Cold Creek Area	Fruit

Edible Wildlife Sampling Locations

Hanford Site	On-site - Deer liver, ducks, upland gamebirds, rabbits
Columbia River	Fish

* TLD - Thermoluminescent Dosimeter

APPENDIX B

INFORMATION SOURCES

UMATILLA ENVIRONMENTAL MONITORING PROGRAM

Idaho

Idaho State Department of Health
Statehouse
Boise, Idaho 83707
Contact: (208) 384-2390

Idaho Department of Water Administration
Statehouse Annex 2
Boise, Idaho
Contact: R. Keith Higgins
(208) 384-2215

Idaho Water Resource Research Institute
University of Idaho
Moscow, Idaho 83843
Contact: (208) 885-6111

U.S. Geological Survey (Water Resources)
230 Collins Road
Boise, Idaho 83702
Contact: (208) 334-1750

Washington

Washington State Water Research Center
Washington State University
Pullman, Washington 99163
Contact: Allen F. Agnew
(509) 335-5531

Washington State Department of Ecology
P.O. Box 829
Olympia, Washington 98504
Contact: John A. Biggs
(206) 753-2800

Washington State Department of Natural Resources
P.O. Box 168
Olympia, Washington 98501
Contact: Bert L. Coles
(206) 753-5327

U.S. Geological Survey (Water Resources Division)
1201 Pacific Avenue, Suite 600
Tacoma, Washington 98402
Contact: (206) 593-6510

Oregon

Oregon Department of Environmental Quality
Terminal Sales Building
1234 S.W. Morrison Street
Portland, Oregon 97205
Contact: Ms. Barbara Seymour
(503) 229-5121

Oregon State Water Resources Board
1158 Chemeketa Street, N.E.
Salem, Oregon 97310
Contact: Mr. Fred Gustafson
(503) 378-3671

United States Geological Survey (Water Resource Division)
847 N.E. 19th Avenue, Suite 300
Portland, Oregon 97232
Contact: (503) 231-2008

United States Corps of Engineers
Portland District
319 S.W. Pine Street
Portland, Oregon 97204
Contact: (503) 221-6021

APPENDIX C

DESCRIPTION OF WATSTORE

AND

STORET DATA BASES

C.1 WATSTORE - U.S. GEOLOGICAL SURVEY'S NATIONAL WATER DATA STORAGE AND RETRIEVAL SYSTEM

The U.S. Geological Survey, through its Water Resources Division, investigates the occurrence, quantity, quality, distribution, and movement of the surface and underground waters that comprise the Nation's water resource. It is the principal Federal water-data agency and, as such, collects and disseminates about 70 percent of the water data currently being used by numerous State, local, private, and other Federal agencies to develop and manage our water resources. As part of the Geological Survey's program of scale computerized system has been developed for the storage and retrieval of water data collected through its activities.

The National Water Data Storage and Retrieval System (WATSTORE) was established in November 1971 to modernize the Geological Survey's existing water-data processing procedures and techniques and to provide for more effective and efficient management of its data-releasing activities. Data may be obtained from WATSTORE through any of the Water Resources Division's 46 district offices listed at the end of this section.

C.1.1 System Description

The Geological Survey currently collects data at approximately 10,000 stream-gaging stations, 1,300 lakes and reservoirs, 4,300 surface-water quality stations, 4,100 water-temperature stations, 880 sediment stations, 2,500 water-level observation wells, and 1,500 ground-water quality wells. Each year many water-data collection sites are added and others are discontinued; thus, large amounts of diversified data, both current, and historical, are amassed by the Survey's data-collection activities.

The WATSTORE system consists of several files in which data are grouped and stored by common characteristics and data-collection frequencies. The system is also designed to allow for the inclusion of additional data files if the need should arise in future years. Currently, files are maintained for the storage of (1) surface-water, quality-of-water, and ground-water data measured ona daily or continuous basins, (2) annual peak values for streamflow stations, (3) chemical analyses for surface- and ground-water sites, and (4) geologic and inventory data for ground-water sites. In addition, an index file of sites for which data are stored in the system is also maintained. A brief description of each file is given below.

C.1.1.1 Station Header File: All sites for which data are stored in the Daily Values, Peak Flow, and Water Quality file of WATSTORE are indexed in this file. It contains information pertinent to the identification, location, and physical description of over 100,000 sites.

C.1.1.2 Daily Values File: All water-data parameters measured or observed either on a daily or on a continuous basis and numerically reduced to daily values are stored in this file. Instantaneous measurements at fixed-time intervals, daily mean values, and statistics such as daily maximum and minimum values also may be stored. This file currently contains over 118 million daily values including data for streamflow values, river stages, reservoir contents, water temperatures, specific conductance values, sediment concentrations, sediment discharges, and ground water levels.

C.1.1.3 Peak Flow File: Annual maximum (peak) streamflow (discharge) and gage height (stage) values at surface water sites comprise this file. It currently contains over 325,000 peak observations.

C.1.1.4 Water Quality File: Results of over 830,000 analyses of water samples that describe the chemical, physical, biological, and radiochemical characteristics of both surface and ground waters are contained in this file. These analyses contain data for more than 200 different constituents.

C.1.1.5 Ground-Water Site Inventory File: This ground water file is maintained within WATSTORE independent of the files discussed above, but it is cross-referenced to the Water Quality File and the Daily Values File. It contains inventory data about wells, springs, and other sources of ground water; the data included are site location and identification, geohydrologic characteristics, well-construction history, and one-time field measurements such as water temperature. The file is still being established and eventually it will contain over 2 million records.

C.1.2 System Operation

All data files of the WATSTORE system are maintained and managed on the central computer facilities of the Geological Survey at its National Center. However, data may be entered into or retrieved from WATSTORE through a number of locations that are part of a nationwide telecommunication network.

C.1.2.1 Remote Job Entry Sites: Almost all of the Water Resources Division's district offices are equipped with high-speed computer terminals for remote access to the WATSTORE system. These terminals provide rapid and efficient access to WATSTORE, and allow each site to put data into or retrieve data from the system within several minutes to overnight, depending upon the priority placed on the request. The number of remote job entry sites is increased as the need arises.

C.1.2.2 Digital Transmission Sites: The Geological Survey operates more than 9,000 data-collection stations that remotely record water data. To provide for current and timely processing and reporting of these data, a transmission network provides for the local translation of data to a computer-compatible form and transmits the translated data over telephone circuits to the National Center's computer facilities. These data are then processed by a computer terminal located at the transmission site. Results obtained by this procedure are simultaneously stored in the Daily Values File of WATSTORE and printed at the transmission site.

C.1.2.3 Central Water-Quality Laboratories: The Water Resource Division has three water-quality laboratories centrally located in Salt Lake City, Utah; Atlanta, Georgia; and Albany, New York. They are used to analyze more than 60,000 water samples per year. These laboratories are equipped to automatically perform chemical analyses that range from determinations of simple inorganic compounds such as chlorides to complex organic compounds such as pesticides. As each analysis is completed, the results are verified by laboratory personnel and then transmitted via a computer terminal to the central computer facilities and stored in the Water Quality File of WATSTORE.

C.1.3 System Products

Water data, as compiled by the Survey, are used in many ways by decision makers for the management, development, and monitoring of our water resources. Thus, in addition to its data processing, storage, and retrieval capabilities, WATSTORE can provide, upon request, a variety of useful data products to meet diverse needs. These products range from the simple retrieval of data in tabular form to complex statistical analyses. A minimal fee plus the actual computer cost incurred in producing a desired product is charged to the requester. Cost estimates for these products may be obtained from the offices listed at this end of section C.1.3.

C.1.3.1 Computer-Printed Tables: Users most often request data from WATSTORE in the form of tables printed by the computer. These tables may contain lists of actual data or condensed indexes that indicate the availability of data stored in the files. A variety of formats are available to display the many types of data.

C.1.3.2 Computer-Printed Graphs: Computer-printed graphs for the rapid analysis or display of data are another capability of WATSTORE. Computer programs are available to produce bar graphs (histograms), line graphs, frequency distribution curves, X-Y point plots, site-location may plots, and other similar items by means of line printers.

C.1.3.3 Statistical Analyses: WATSTORE uses the Geological Survey's collection of computer programs known as STATPAC (Statistical Package) to provide extensive analyses of data such as regression analyses, the analysis of variance, transformations, and correlations.

C.1.3.4 Digital Plotting: WATSTORE also makes use of software systems that prepare data for digital plotting on peripheral, offline plotters available at the central computer site. Plots that can be obtained include hydrographs, frequency distribution curves, X-Y point plots, contour plots, and three-dimensional plots.

C.1.3.5 Data in Machine-Readable Form: Data stored in WATSTORE also can be obtained in machine-readable form for use on other computer or for use as input to user-written computer programs. These data are available in the standard storage format of the WATSTORe system or in the form of punch cards or punch card images on magnetic tape.

C.1.4 WATSTORE Assistance

Inormation about the availability of specific types of data, the acquisiton of data or products, and user charges can be obtained locally from each of the Water Resources Division's district offices listed below.

IDAHO, Boise
MONTANA, Helena
OREGON, Portland

C.2 STORET - EPA'S COMPUTERIZED WATER QUALITY DATA BASE

STORET is a computerized data base utility maintained by EPA for the storage and retrieval of parametric data relating to the quality of the waterways of the United States. The system was conceived and initiated under the auspices and administration ofthe Public Health Service in the early 1960's. Since its early days when STORET input and output was achieved via the mails, the system has evolved into a comprehensive information data base, accessible by hundreds of users via computer terminals located throughout the country.

In order to achieve our national objective of having water that is clean enough both for recreational activity and for the protection of fish and wildlife, numerous research and development efforts have been initiated to acquire a through understanding of the complex and variable biological systems that characterize our waterways. Research tells us what a specific level of a specific pollutant does to human, animals, and crops. It establishes thresholds at which we might expect adverse effects from environmental pollutants, alone or in combination. (And from these thresholds, criteria for water quality standards can be established.) It provides the basic scientific knowledge we need to safeguard the public health and to balance the benefits of a specific product against its environmental risks.

Some 1800 unique water quality parameters are defined within STORET. Approximately 80% of the 40 million individual observations available within the system pertain to approximately 200 of these parameters which are grouped into the general categories of: radiological, phosphorus, pesticides, flow, biological, bacteriologic, solids, nitrogen, oxygen demand, general organics, dissolved oxygen, metals, and physical properties. A single observation represents a measurement of a single parameter at a specific location, or station, at a specific point in time.

STORET contains data on samples taken from more than 200,000 unique collection points located on essentially all of the Nation's rivers, lakes, streams, and other waterways. The shadings of the map reflect the relative concentrations of sampling and monitoring stations.

C.2.1 Basin Planning

A river basin is the area drained by a single river and its tributaries. A water quality management basin plan is a management document that identifies the water quality problems of a particular basin, or portion of a basin, and sets forth an effective remedial program to alleviate those problems. Overall basin needs and priorities are assessed, actions scheduled, and the necessary coordination with concerned organizations planned.

The needs and priorities are based largely upon water quality data and the analysis of this data. For example, fecal coloform bacteria is a common indicator of pollution problems in areas affected by major municipal/industrial activity. A plot of coliform along a stretch of a river can quickly ascertain the presence of a bacterial source and the extent of a pollution problem.

The development of an effective planning process is crucial to effective water quality management. This is particularly true for river basin planning as required under various sections of PL 92-500. River basin plans are primarily the responsibility of the states, and the law delineates the rather extensive amount of information that must be provided.

C.2.2 Research

A representative effort is that of the EPA Grosse Ile Laboratory's Research Program to improve the water quality of the Great Lakes.

Since this is an on-going, international program involving both water quality management and research, it is essential that all data gathered on the water quality of the Great Lakes be readily accessible by all investigators. Accordingly, all participants are required to enter all collected data into STORET, thereby greatly expediting the use and analysis of the information through sharing of data. This significant, multi-organizational research program not only illustrates the value of STORET in research-oriented endeavors, but also it demonstrates how the use of an accepted central system can foster cooperation among a group of organizations sharing common interests.

C.2.3 Monitoring and Surveillance

The data in STORET originates from samples taken as part of individual monitoring programs conducted by the states and other organizations. Several objectives of these monitoring efforts are to identify and assess quantitatively the magnitude of existing and potential water pollution problems, and to detect any trends or changes over a period of time. Reports showing, for example, presence of phosphates and ammonia as a function of time, vividly point out where problems do and do not exist.

C.2.4 NPDES Permit Program Far-reaching goals were established by PL 92-500. By 1983, water is anticipated to be clean enough for swimming, boating, and protection of fish, shellfish, and wildlife. To achieve these ambitious but essential goals, the law established a national permit program, known as NPDES—the National Pollutant Discharge Elimination System, to control the discharge of pollutants into any waterway. This program is the mechanism for insuring that effluent limits are met, that the necessary technology is applied, and that all requirements of the 1972 law for controlling discharges and complying with water quality standards are met on schedule. Permits are to be granted to individual dischargers only after they show that their effluents will not contaminate a waterway in excess of established water quality standards, or will not lower its existing quality.

The law allows polluters time to improve facilities, but provides that corrective programs must meet the "best practicable" and "best available" standards of water pollution control technoloby by 1977 and 1983, respectively.

C.2.5 Progress Report

Under Section 305(b) of PL 92-500, states are required to submit annual reports to EPA on sources of pollution—their nature, extent, recommendations for control, and the cost of these controls. As practices become more sophisticated, these reports should reflect the effects of these sources on the pollution of ground waters, and provide an inventory of wells which can be used to determine ground water quality within a state's jurisdiction.

C.2.6 Standards and Criteria

Associated with specific water uses are the water quality standards which must be met in order for the water to be used for its intended purposes consistent with the 1983 goals of water quality. Once standards have been established by states in accordance with national criteria, it is necessary to monitor the effect of water pollution abatement and control activities relative to those criteria. A number of STORET report programs can be used to track the progress of water quality improvements efforts.

C.2.7 Toxic Substances

Although many substances are potentially toxic to aquatic life and other organisms when present in sufficient concentration for a sufficient period of time, the term toxic substances generally refers to those substances which are dangerous even in very low concentration. Consequently, the 1977 and 1983 deadlines for limiting pollutant discharges do nt apply in the cases of these deadly substances, such as mercury, cadmium, and toxaphene. Steps required to meet standards established for toxic substances must be taken quickly to protect the public health and welfare. To this end, EPA is empowered to restrain discharges of any pollutants which present an imminent and substantial endangerment to the health or livelihood of the public.

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