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Private Fuel Storage, L.L.C.

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John L. Donnell, P.E., Project Director

August 9, 2001

Ms. Jane Nakad
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JURISDICTIONAL DETERMINATION FOR WATERS OF THE U.S.
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

Reference: August 6, 2001 conference call between PFS, S&W, NRC, BIA, STB, and EPA

As requested by the NRC, Private Fuel Storage (PFS) is providing the information listed below to help familiarize you with the issues discussed in the above referenced conference call. The following documents are enclosed:

1. Section 2.4 of the Safety Analysis Report (SAR). This section is entitled "Surface Hydrology" and includes discussions on floods, flood history, flood design considerations, etc.
2. Section 2.5 of the Environmental Report (ER). This section is entitled "Hydrology" and includes discussions on floods, flood protection requirements, etc.
3. The Great Salt Lake and Southern Railroad: Wetland and Stream Survey. This survey was performed to determine if any jurisdictional waters of the United States, particularly wetlands or perennial, intermittent, or ephemeral streams, are present along the rail alignment.
4. PFS letter, Donnell to U.S. NRC, PFS Environmental Report – Chapter 9 (Rev 13) Clarification, dated July 12, 2001. This letter provided the NRC with clarifying information regarding environmental permits necessary for the construction and operation of the Private Fuel Storage Facility.

During the conference call you inquired as to whether PFS had considered the impact of potential flooding in making our determination as to whether jurisdictional waters of the U.S. are present in the project area. PFS did consider flooding and as you will see in the survey (i.e., The Great Salt Lake and Southern Railroad: Wetland and Stream Survey) we developed a comprehensive matrix to evaluate all of the arroyos and this matrix included the evaluation of flow characteristics for all the topographic features encountered. The delineation was, therefore

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based on the evaluation of any evidence of flow even if caused by an infrequent. flood-type event. This information was developed to establish the survey as a definitive study of the streams in the vicinity of the PFS Facility. The data in the study reflect that -- even under the broadest interpretations of jurisdictional waters of the U.S. -- the features are not tributary to any waters and are not jurisdictional.

On a potentially related issue. we note that the U.S. Army Corps of Engineers recently released guidance for conducting delineations in the arid southwest. (FINAL SUMMARY REPORT: GUIDELINES FOR JURISDICTIONAL DETERMINATIONS FOR WATERS OF THE UNITED STATES IN THE ARID SOUTHWEST, June 2001). The guidance establishes the Corps' position regarding storm event size for evaluating Ordinary High Water Marks and provides additional information for conducting jurisdictional delineations in the region. For your reference, section 2.2 of this report on page 8 states the following:

> "When conducting jurisdictional determinations in arid areas. Regulators and environmental consultants should be cognizant of the above physical characteristics of dryland fluvial systems and insure that the horizontal extent of our jurisdiction includes small to moderate storm events, but is not so expansive that it incorporates field evidence from the 25-year, 50-year or 100-year storm event."

PFS believes that the conclusions reached in the Wetland and Stream Survey conducted in the project area are consistent with longstanding jurisdictional criteria and the above-referenced guidelines. Additionally PFS believes that the jurisdictional determination and the environmental approvals and consultations discussed in Chapter 9 of the ER are in compliance with all applicable codes, regulations and guidelines.

If any concerns or questions remain on your part after reviewing the included information, PFS would be very interested in further dialog or a site visit to Skull Valley with you to resolve any remaining issues. If you have any questions or need additional information please contact me at 303-741-7009.

Sincerely,

J J Cooper for

John L. Donnell
Project Director
Private Fuel Storage L.L.C.

Enclosure

Copy to:

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2.4 SURFACE HYDROLOGY

2.4.1 Surface Hydrologic Description

The PFSF site is situated near the middle of Skull Valley about 24 miles south of highway I-80 and the Great Salt Lake. Figure 2.4-1 shows the topography of the site and surrounding area. Skull Valley was formerly occupied by Lake Bonneville, an inland sea that covered the area from about 30,000 to 10,000 years before present (B.P.). The valley is nearly 50 miles long and 22 miles wide at its widest point and slopes gently northward to Great Salt Lake at approximately 30 ft per mile.

North-south trending mountain ranges rise abruptly from the valley floor on both sides. On the east side of the valley, the Stansbury Mountains rise to 11,031 ft elevation at Deseret Peak, while on the west side, the Cedar Mountains rise to about 7,600 ft elevation. Both ranges are composed mainly of limestone and dolomite with lesser amounts of quartzite, sandstone, and shale, ranging in age from Early Cambrian to Tertiary.

A thick alluvial apron exists at the base of the ranges, formed by a series of coalescing alluvial fans. This apron (or bajada) is composed mainly of coarse clastic material derived from erosion of the adjacent ranges by high gradient streams. The surface of the bajada in the vicinity of the PFSF site slopes westward at about 165 ft per mile and meets the valley bottom about 1.5 miles east of the PFSF location.

Precipitation in Skull Valley ranges from 7 to 12 inches per year with only about one-third that amount falling during the growing season (Hood and Waddell, 1968). The uplands receive considerably more precipitation, up to 40 inches in the Stansbury Mountains and 16 to 20 inches in the lower Cedar Mountains. Much of this is in the form of snow that enters the hydrologic system as runoff in the spring. However, very little of this water actually reaches the valley bottom as stream flow.

The pervious unconsolidated deposits of the bajada intercept runoff and serve as the main zone of recharge to the groundwater system. As a consequence, there are few perennial streams in Skull Valley and none in the vicinity of the site. The poorly developed intermittent drainages are mainly dry washes incised a few feet into the valley bottom. All of these washes in the site vicinity drain northward or northwestward and likely carry water for only short periods during spring runoff or during infrequent summer thunderstorms.

At a few locations in Skull Valley, especially along the eastern foothills, ground water intersects the surface in the form of springs. These springs have created surface channels, such as those near Timpie and Delle. In general, most spring flow is lost to the recharge area or is consumed by evapotranspiration. No springs occur within a 5-mile radius of the site. The nearest perennial surface flow downstream from the proposed site occurs about 10 miles to the north near Salt Mountain. This flow is attributed mainly to springs at the base of the hill, west of Skull Valley Road. It eventually joins other spring and stream flow, creating a large wetland/mudflat system, before draining to Great Salt Lake.

There are no perennial lakes or ponds in the site area other than a few stock ponds or small reservoirs built for irrigation purposes. These impoundments are commonly filled by water diverted in ditches or pipelines whose sources are in the canyons of the Stansbury Mountains.

There are no public or private surface drinking-water supplies in the site vicinity. Potable water supplies for the Skull Valley Indian Reservation, and the few scattered ranches or farms along the east side of the valley, are wells drilled into the unconsolidated or semi-consolidated sediments that form the alluvial fan along the base of the Stansbury Mountains. Consequently, there is no potable surface water supply that could be subject to normal or accidental effluents from the facility.

2.4.1.1 Site and Structures

The land surface at the site is approximately 4,465 ft elevation and is nearly flat, sloping gently to the north. A few shallow, dry washes and former beach or lake bottom features provide slight relief to the site area. Desert shrubs and grasses form a thin vegetative cover.

No streams that would even be considered intermittent cross the facility area. The closest stream with a significant channel crosses the northeast corner of Section 6 and the center of Section 5, about 1,500 ft from the northeast corner of the facility (Figure 2.4-1). The channel is up to 3 ft deep and 6 to 8 ft wide in some areas. It carried no water during the observation period between June 1996 and February 1997.

The facility and its structures are described in Chapter 1. The PFSF storage area is approximately 99 acres. The storage area is graded for surface drainage with slopes from south to north of approximately 0.5%. Site elevations vary from approximately 4,460 ft at the north to 4,470 ft at the south. A stormwater detention basin is located on the north side of the storage area to collect runoff from the storage area.

2.4.1.2 Hydrosphere

Watersheds contributing runoff to the areas of the access road and the 3-mile-long rail road adjacent to the PFSF site are shown in Figure 2.4-1. Watershed runoff contributing to the access road area is primarily from the east mountain range of the valley, and is designated as Basin A in Figure 2.4-1. Basin A is a watershed comprising an area of approximately 270 square miles. Watershed runoff contributing to the 3-mile-long rail road adjacent to the PFSF site is from the west mountain range on the west of the valley, and is designated as Basin B in Figure 2.4-1. Basin B is a watershed comprising an area of approximately 64 square miles (40,960 acres). The PFSF is separated from Basin A and Basin B by an earthen berm proposed for construction to keep out runoff from the two basins. The topography and approximate sheet flow directions in the site vicinity are also shown in Figure 2.4-1.

A major portion of Basin A runoff originates in the east upland extending from the lower Stansbury Mountains to the Lookout mountain in the south. Runoff is drained into the valley by a number of intermittent streams (see Figure 2.4-1). The flow from the mountain front, after crossing the alluvial fans at the foothills of the mountains is quickly lost to the pervious sublayer and evapotranspiration to become an intermittent stream. Stream flow would be produced only by very heavy rainfall or during snowmelt conditions.

Basin B runoff is primarily from the upland in the Lower Cedar Mountains on the west of PFSF. The runoff converges to the 3-mile-long rail road through many small streams. Similar to Basin A, these small streams are normally dried, stream flow can only be seen after a heavy thunder storm.

During site visits conducted between June 1996 and February 1997, several hydrologic observations were made. No perennial streams were observed to cross Skull Valley road from the uplands to the east, nor were any perennial streams observed west of the site to the base of the Cedar Mountains. There are no upstream or downstream flow control structures whose failure could conceivably affect the site or its access road. The only structures located in the area are very small reservoirs in the foothills used as stock ponds or for collection of water for irrigation purposes.

Hood and Waddell (1968) indicate that the groundwater table in Skull Valley in the vicinity of the site ranges from elevation 4,300 to 4,350 ft. The groundwater table at the site is at approximate elevation 4,350 ft, a depth of approximately 125 ft based on a monitoring well near the Canister Transfer Building (CTB), installed in early 1999. This value is consistent with the upper bound of the range of depths to the water table reported by Geosphere Midwest (Appendix 2B), who report seismic refraction results indicate that the water table may be located at depths of between 90 and 136 ft (Seismic Lines 1, 2, & 3) below existing grade. Because of the great depth to the groundwater table, it is very unlikely that the groundwater regime could have any influence on the stability of structures at the site.

2.4.2 Floods

There is no evidence the site area has experienced flooding in the past. Storm-induced runoff will provide sheet flow toward the site which will easily be controlled by construction of short diversion berms near the southern portions of the PFSF.

Analyses of the probable maximum precipitation were performed to determine a PMF for stormwater drainage Basins A (SWEC, 1999a) and B (SWEC, 1999c). The analyses demonstrated that the site would not be in the flood plain caused by any flood event.

2.4.2.1 Flood History

The PFSF site is located in an area of western Utah with a semi-arid climate, receiving average annual precipitation of 7 to 12 inches (Hood and Waddell, 1968). There are no perennial water courses within 4 miles of the site. The nearest streams are high gradient streams that drain the slopes of the Stansbury Mountains through steep-walled canyons. This flow is quickly lost to the unconsolidated sediments comprising the alluvial apron at the foot of the mountains and becomes part of the groundwater system. No perennial surface flow makes its way across Skull Valley road which runs north-south, approximately 1.5 miles east of the PFSF site.

There is no evidence of past flooding in the site area and only minor development of drainage channels created by infrequent thunderstorms (<1 to 2 ft deep). There is no evidence of flash-flooding in the area, such as flood deposits, nor are there channels that could affect the site if they were subject to a flash flood.

The only conceivable scenario for floods would involve a return to climatic conditions of the Late Pleistocene causing a significant rise (~300 ft) in the level of Great Salt Lake. Those conditions generally require millennia to develop, therefore, this scenario is dismissed.

2.4.2.2 Flood Design Considerations

Hypothetical Probable Maximum Precipitation (PMP) events were analyzed to determine maximum flooding elevation at the PFSF site due to flood flows from Basin A and Basin B. The analyses included the general storm and the local storm events, as discussed below in Section 2.4.2.3. Determination of Probable Maximum Flood (PMF) was based on the procedures given in Hydrometeorological Report (HMR) 49 (U.S. Department of Commerce, 1977). In Basin A, the PMF is generated by a general storm, while in Basin B, it is generated by a local storm.

For an extremely conservative PMF (flow = 85,000 cfs for Basin A, 102,000 cfs for Basin B, detailed in Section 2.4.2.3), results of hydraulic analysis indicate that maximum water surface elevation is predicted to be 4,506.4 ft upstream of the access road and the PMF berm in the east floodway with runoff from Basin A, and 4,478.2 ft upstream of the rail spur and the PMF berm in the west floodway from Basin B. Both of the predicted flood elevations are below the designed top elevations of the PMF diversion berms of 4,507.5 ft and 4,480 ft, respectively. At cross sections downstream of the access road, rail spur and the PMF berms, the predicted flood elevations (SWEC 1999d) are below the designed site grade elevations of 4,463 ft to 4,475 ft. Consequently, all Structures, Systems, and Components (SSCs) classified as being Important to Safety are located above the PMF flood plains.

Figures 2.4-2, 2.4-3, 2.4-4 and 2.4-5 show a plan and profile (elevation) views of the PFSF site PMF berm, the PFSF rail line, the PFSF access road, and the PFSF access road PMF berm, respectively. In each of these figures, the maximum PMF water level is also shown in the profile view.

The results of the PMF analyses (SWEC, 1999d) demonstrate that the floodwater from the PMF will not inundate the pad emplacement area. In the discussion that follows, note that the elevations of the tops of the cask storage pads range from a low of Elevation 4,463 ft at the northern end of the pad emplacement area, to a high of Elevation 4,475 ft at the southern end. These are shown in Pad Emplacement Area Foundation Profiles 7-7' through 12-12', presented as Sheets 9 through 14 of Figure 2.6-5. The locations of these profiles are presented on Figure 2.6-19.

Figure 1 of SWEC (1999d) identifies the locations of Drainage Basins A and B, which are also shown on Figure 2.4-1. Figure 8 of this calculation presents a plan view of the PMF flood boundaries, and it indicates that the PMF boundaries for both Basins A and

B do not reach the site, because of the PMF Diversion Berm. Figure 3 presents the PMF water surface profile at the Access Road from Drainage Basin A. It illustrates that, although the flood waters pass over the top of the Access Road approximately 5,000 ft east of the site and floods the area to the northeast of the site, the surface of the flood is much lower in the vicinity of the PFSF.

Figure 8 (SWEC, 1999d) illustrates that in the northeast corner of the pad emplacement area, the maximum flood water level is Elevation 4,456.74 ft. The tops of the closest (and lowest) cask storage pads in this area are at Elevation 4,463 ft. Thus, the elevation of the pads at this point is greater than 6 ft above the PMF elevation. This is also illustrated in Figure 5 of the calculation, which presents a cross-section view of the PMF water level near the northeast corner of the PFSF site. Figure 8 also illustrates that, at the entrance of the Access Road to the PFSF, which is east of the Canister Transfer Building, the maximum elevation of the PMF is only 4,466.39 ft. The final grade in this area of the PFSF is Elevation 4,475, which is also the elevation of the tops of the closest cask storage pads. Thus, the elevations of the closest pads are greater than 8 ft above the PMF elevation in this area of the PFSF. Therefore, the site will not be inundated by the maximum water levels due to the PMF occurring within Drainage Basin A.

Figures 6 and 7 of the calculation present similar information for the PMF occurring within Drainage Basin B, which impacts the railroad west of the PFSF. The boundary of the PMF in Basin B is also shown in plan view on Figure 8. As indicated in these figures, the maximum elevation of the PMF near the PFSF site at the railroad crossing is 4,478.22 ft, which is higher than the tops of the cask storage pads in the south and west corner of the pad emplacement area. However, this floodwater is precluded from reaching the pad emplacement area by the PMF Diversion Berm, which has a top elevation of 4,480 ft. Where the PMF Diversion Berm ends near the middle of the western edge of the pad emplacement area (Figure 2.6-2, Sheet 1), the PMF water level is only as high as Elevation 4,464.83 ft. The tops of the cask storage pads east of that area are at Elevation 4,469 (shown in Pad Emplacement Area Foundation Profile 7-7', Sheet 9 of Figure 2.6-5), which is greater than 4 ft above the PMF elevation. Therefore, the site will not be inundated by the maximum water levels due to the PMF occurring within Drainage Basin B.

Stormwater runoff from Basin A and Basin B drains as a sheet flow toward the PFSF site. An earthen berm (PMF berm) and drainage ditch system will be constructed on the south and west sides of the PFSF storage site to divert the PMF stormwater flows around the site to the east floodway and the west floodway. Consequently, all Structures, Systems, and Components (SSCs) classified as being Important to Safety are protected from the sheet flows associated with the PMF from Basin A and Basin B by the PMF berm.

The PFSF site drainage systems (both offsite and onsite) are designed for the 100-yr storm event. Offsite drainage system design due to Hickman Knolls runoff is conveyed around the south and west sides of the PFSF. This flow is then discharged at a permissible velocity to the Skull Valley natural drainage system. Flows resulting from a storm event more severe than a 100-yr event from Hickman Knolls are also diverted into the Skull Valley drainage system. Onsite drainage system design due to local runoff is conveyed by a surface flow system utilizing swales channeled to a stormwater collection and detention basin where it can evaporate and seep into the soil.

The PFSF access road and the rail road drainage systems are designed to safely convey the surface water under the roadway during a 100-yr storm event. During a PMP, the excess runoff will overtop the access road embankment and the rail road embankments. The flood overflow will be contained with a north-south berm tied into Hickman Knolls to prevent flows from approaching the PFSF site. Downstream of the access road and the rail road, the PMF returns to the natural flow conditions. Access to the site by normal vehicular traffic, as well as emergency vehicles, will be provided at all times except during a storm which is more severe than a 100-yr storm event.

2.4.2.3 Effects of Local Intense Precipitation

The PMP was estimated based on HMR 49. HMR 49 requires different evaluations for combinations of storm events. Although the PMF generated by a general storm is a major concern in the evaluation of maximum flow, the local thunder storm in the summer time, having the greatest potential rain fall intensity and short duration may produce a larger PMF. Consequently, the PMP for both general storm and local storm must be analyzed. The PMP events are used with the HEC-1 program (U.S. Army Corps of Engineers, 1990) to determine peak discharges. After these evaluations are completed, the largest peak discharge is selected as the PMF. The water surface profile corresponding to the PMF is determined with the HEC-RAS (U.S. Army Corps of Engineers, 1997) backwater program.

According to the procedures given in HMR 49, the total precipitation for the general PMP were estimated to be approximately 10.7 and 10.5 inches during a 24-hour duration for the month of August (SWEC, 1999a, 1999c) at the Basin A and Basin B, respectively.

The total precipitation during the local PMP were estimated to be approximately 14.1 and 12.7 inches during a 6-hr duration at the Basin A and Basin B, respectively.

The 1-hr local PMP induced by a short duration thunderstorm over a 1 square mile basin at the site was determined to be 10.1 and 9.8 inches at the Basin A and Basin B, respectively. Durational variation and areal reduction described in HMR 49 were employed to estimate the incremental PMP.

The total duration of the PMP was divided into six increments. The sequence position of hourly incremental PMP for the 6-hr thunderstorm was arranged in accordance with HMR No. 5 (U.S. Weather Bureau, 1947) as shown in the following table:

Increment	HMR No. 5 Sequence Position
Largest hourly amount	Third
2nd largest	Fourth
3rd largest	Second
4th largest	Fifth
5th largest	First
least	Last

The local PMP depths at 15-minute intervals for the first hour were determined by the procedures provided in HMR 49. The remaining 15-minute intervals were estimated from the depth-duration curve as documented in the calculation (SWEC, 1999a, 1999c). The sequence of the four 15-minute incremental PMP has the greatest intensity in the first 15-minute interval. The second, the third, and the fourth largest were placed after.

The general PMP depths at 1st, 6th, 12th, 18th, 24th, 48th, and 72nd hours were determined by HMR 49. The remaining 3-hr increments can be found from the depth-duration relationship. Time distribution procedures given by the Corps of Engineers (U.S. Army, 1952) were used for all other storms except the local PMP. The total duration of the storm was divided into four increments. The increments were arranged in a sequence with the largest one at the middle and decreased progressively to either side of the greatest increment.

The HEC-1 computer program (US Army, COE, 1990) was used to determine the peak discharge. Soil type and its corresponding hydrological group, runoff curve number (CN), were estimated based on USDA's unpublished county soil report. The Utah Division of Water Resources suggested CN=70 for the type of soil surface condition in the Skull Valley. Consequently, CN=70 was assumed in the calculation.

The Kirpich formula (Chow, 1964) was used to estimate the time of concentration (Tc) for the overland flow on grassed surface. Based on the measured watershed length and the slope of the basin, the time of concentration at Basin A was calculated to be 11.24 hours. For Basin B, the time of concentration was estimated to be 4.17 hours, by using the regression equation developed by U.S. Corps of Engineer ("Time of Concentration vs Drainage Area for Mountain Watershed in Utah", no date, provided by Water Resource Division, State of Utah).

Based on the HEC-1 ,model computer output, the results of the PMF are summarized in the following:

	Basin A	Basin B
$Q_{Local\ PMF}$ =	40,237 cfs	68,500 cfs
$Q_{General\ PMF}$=	52,983 cfs	20,972 cfs

The larger peak discharge is selected as the PMF for the basin:

Q_{PMF}=	53,000 cfs	68,500 cfs

An extremely conservative case that is unlikely to happen in the Skull Valley drainage basin was also analyzed. In Basin A, assuming CN = 96 and Tc = 11 hours, the calculated PMF = 85,000 cfs. In Basin B, assuming CN=96, and Tc = 4.17 hours, the calculated PMF = 102,000 cfs. A CN = 96 is equivalent to an impervious surface or a saturated ground condition.

For the design of the access road and the railroad spur, the 100-yr floods for Basin A and B were estimated (SWEC, 1999a, 1999c) from the FHWA method (FHWA, 1977) and USGS method (USGS, 1994). The results of the 100-yr flood are summarized in the following

	Basin A	Basin B
$Q_{100\ (FHWA)}$ =	2,430 cfs	1,391 cfs
$Q_{100\ (USGS)}$ =	2,317 cfs	936 cfs

The larger peak flow is selected as the 100-yr flood for the basin

Q_{100} =	2,430 cfs	1,400 cfs

As described above, the extremely conservative PMF flows were calculated to be 85,000 cfs and 102,000 cfs for Basin A and Basin B, respectively. The PMF would most likely flow to the north along the east and west fringe of the PFSF site to Great Salt Lake. The peak discharges of 85,000 cfs and 102,000 cfs were used for backwater computation. The computer program HEC-RAS (US Army, COE, 1997) was used to compute Basin A and Basin B maximum flood profile elevations at various cross section and flood plains at the vicinity of the site (SWEC, 1999a, 1999c, 1999d).

For Basin A, with existing natural topography the predicted maximum water elevation is 4,501.3 ft at the access road (SWEC, 1999a). The predicted flood levels at the southeast and northeast corners of the site are approximately 4,468.8 ft and 4,456.7 ft, respectively. The site elevation of 4,475 – 4,463 ft is above the calculated water elevations. Consequently, the site is not in Basin A PMF flood plain.

In addition, the PMF flood levels for Basin A and B after the construction of the access road and rail line embankment were calculated. The predicted maximum water elevation at the access road and rail road is 4,506.4 and 4,478.1 ft, respectively.

All Structures, Systems, and Components (SSCs) classified as being Important to Safety are protected from the sheet flow associated with Basin A and B PMF by an earthen berm to be built with top elevation at 4,507.5 and 4,480.0 ft, respectively.

2.4.3 Potential Maximum Flood on Streams and Rivers

Since there are no perennial streams or rivers in the vicinity of the PFSF, a PMF analysis is not required on streams and rivers. However, an ephemeral stream bed is present; therefore, PMF analyses were performed for this ephemeral stream as described above in Section 2.4.2.3.

2.4.4 Potential Dam Failures (Seismically Induced)

There are no flow control structures on any stream upgradient from the site; therefore, there is no potential for impact on the site from potential dam failures.

2.4.5 Probable Maximum Surge and Seiche Flooding

No surge or seiche flooding is possible, as there is no large water body near the site.

2.4.6 Probable Maximum Tsunami Flooding

The site is not located near a coastal area. As a result no tsunami sea waves are anticipated.

2.4.7 Ice Flooding

There are no water bodies near the site on which ice flooding conditions could arise.

2.4.8 Flooding Protection Requirements

All Structures, Systems, and Components (SSCs) classified as being Important to Safety are protected from flooding by diversion berms to deflect potential flows generated by PMF from both the east mountain range (Basin A) and the west mountain range (Basin B) watersheds.

2.4.9 Environmental Acceptance of Effluents

With the exception of the sanitary system, there are no liquid releases that result from the normal operation of the PFSF.

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2.5 HYDROLOGY

2.5.1 Surface Hydrology

The PFSF is situated near the middle of Skull Valley about 24 miles south of Interstate 80 and the Great Salt Lake. Figure 2.5-1 shows the topography of the PFSF and the surrounding area. Skull Valley was formerly occupied by Lake Bonneville, an inland sea that covered the area from about 30,000 to 10,000 years before present (B.P.). The valley is nearly 50 miles long and 22 miles wide at its widest point and slopes gently northward to the Great Salt Lake at approximately 30 ft per mile.

North-south trending mountain ranges rise abruptly from the valley floor on both sides. On the east side of the valley, the Stansbury Mountains rise to 11,031 ft elevation at Deseret Peak, while on the west side, the Cedar Mountains rise to about 7,600 ft elevation. Both ranges are composed mainly of limestone and dolomite with lesser amounts of quartzite, sandstone, and shale, ranging in age from Early Cambrian to Tertiary.

A thick alluvial apron exists at the base of the Stansbury range, formed by a series of coalescing alluvial fans. This apron (or bajada) is composed mainly of coarse clastic material derived from erosion of the adjacent ranges by high gradient streams. The surface of the apron in the vicinity of the PFSF slopes westward at about 165 ft per mile and meets the valley bottom about 1.5 miles east of the PFSF location.

Precipitation in Skull Valley ranges from 7 to 12 inches per year with only about one-third that amount falling during the growing season (Hood and Waddell, 1968). The uplands receive considerably more precipitation, up to 40 inches in the Stansbury Mountains and 16 to 20 inches in the lower Cedar Mountains. Much of this is in the form of snow that enters the hydrologic system as runoff in the spring. However, very little of this water actually reaches the valley bottom as stream flow.

The pervious unconsolidated deposits of the bajada intercept runoff and serve as the main zone of recharge to the groundwater system. As a consequence, there are few perennial streams in Skull Valley and none in the vicinity of the PFSF. The poorly developed intermittent drainages are mainly dry washes incised a few feet into the valley bottom. All of these washes in the PFSF vicinity drain northward or northwestward, and likely carry water for only short periods during spring runoff or during infrequent summer thunderstorms.

At a few locations in Skull Valley, especially along the eastern foothills, groundwater intersects the surface in the form of springs. These springs have created surface channels, such as those near Timpie and Delle. In general, most spring flow is lost to the recharge area or is consumed by evapotranspiration. No springs occur within a 5-mile radius of the PFSF. The nearest perennial surface flow downstream from the PFSF occurs about 10 miles to the north near Salt Mountain. This flow is attributed mainly to springs at the base of the hill, west of Skull Valley Road. It eventually joins other spring and stream flows creating a large wetland/mudflat system before draining to the Great Salt Lake.

There are no perennial lakes or ponds within 5 miles of the PFSF or along the Low Corridor, other than a few stock ponds or small reservoirs built for irrigation purposes. These impoundments are commonly filled by water diverted in ditches or pipelines whose sources are in the canyons of the Stansbury Mountains.

There are no public or private surface drinking water supplies in the PFSF vicinity. Potable water supplies for the Skull Valley Indian Reservation, and the few scattered ranches or farms along the east side of the valley, are wells drilled into the unconsolidated or semi-consolidated sediments that form the alluvial fan along the base of the Stansbury Mountains. Consequently, there is no potable surface water supply that could be subject to normal or accidental effluents from the facility.

Water, including potable supplies, will be required during construction and operation of the PFSF. Water requirements will be modest and similar to a light industrial facility with a 24 hour-per-day work force. The highest water demand will occur during construction for dust control and operation of the concrete batch plant. Source water may come from several water wells drilled and developed at the PFSF or from offsite sources. Wells would be located so that they have no impact on any existing wells in the vicinity of the PFSF.

The land surface at the PFSF is nearly flat and slopes gently downward to the north, from approximate elevation 4,470 ft at the south end to 4,460 ft at the north end. A few shallow, dry washes and former beach or lake bottom features provide slight relief to the PFSF site area. Desert shrubs and grasses form a thin vegetative cover.

No streams that would even be considered intermittent cross the facility area. The closest stream with a significant channel crosses the northeast corner of Section 6 and the center of Section 5, about 1,500 ft from the northeast corner of the facility (Figure 2.5-1). The channel is up to 3 ft deep and 6 to 8 ft wide in some areas. It carried no water during the observation period between June 1996, and February 1997.

Watersheds contributing runoff to the areas of the access road and the 3-mile-long rail road adjacent to the PFSF site are shown in Figure 2.5-1. Watershed runoff contributing to the access road area is primarily from the east mountain range of the valley, and is designated as Basin A in Figure 2.5-1. Basin A is a watershed comprising an area of approximately 270 square miles. Watershed runoff contributing to the 3-mile-long rail road adjacent to the PFSF site is from the west mountain range on the west of the valley, and is designated as Basin B in Figure 2.5-1. Basin B is a watershed comprising an area of approximately 64 square miles (40,960 acres). The PFSF is separated from Basin A and Basin B by an earthern berm proposed for construction to keep out runoff from the two basins. The topography and approximate sheet flow direction in the PFSF vicinity are also shown in Figure 2.5-1.

A major portion of Basin A runoff originates in the east upland upland extending from the lower Stansbury Mountains to the Lookout mountain in the south.. Flood runoff is drained into the valley by a number of intermittent streams (see Figure 2.5-1). The flow from the mountain front, after crossing the alluvial fans at the foothills of the mountain, is quickly lost to the pervious sublayer and evapotranspiration to become an intermittent stream. Stream flow would be produced only by very heavy rainfall or during snowmelt conditions.

Basin B runoff is primarily from the upland in the Lower Cedar Mountains on the west of PFSF. The runoff converges to the 3-mile-long rail road through many small streams. Similar to Basin A, these small streams are normally dried, stream flows can only be seen after a heavy thunder storm.

During PFSF site visits conducted between June 1996 and February 1997, several hydrologic observations were made. No perennial streams were observed to cross Skull Valley road from the uplands to the east, nor were any perennial streams observed west of the PFSF to the base of the Cedar Mountains. There are no upstream or downstream flow control structures whose failure could conceivably affect the PFSF or its access road. The only structures located within 5 miles of the PFSF are very small reservoirs in the foothills used as stock ponds or for collection of water for irrigation purposes.

2.5.2 Floods

The PFSF is located in an area of western Utah with a semi-arid climate, receiving average annual precipitation of 7 to 12 inches (Hood and Waddell, 1968). There are no perennial water courses within 4 miles of the PFSF. The nearest streams are high gradient streams that drain the slopes of the Stansbury Mountains through steep-walled canyons. This flow is quickly lost to the unconsolidated sediments comprising the alluvial apron at the foot of the mountains and becomes part of the groundwater system. No perennial surface flow makes its way across Skull Valley road which runs north-south approximately 1.5 miles east of the PFSF.

There are no active streams in the PFSF vicinity and no average or maximum annual flow rates are available. There are no perennial streams in the PFSF vicinity and no dry stream channels that show evidence of flash flooding. There is no evidence of past flooding in the PFSF site area and only minor development of drainage channels created by infrequent thunderstorms (<1 to 2 ft deep). There is no evidence of flash-flooding in the area, such as flood deposits, nor are there channels that could affect the PFSF if they were subject to a flash flood.

The PFSF location has not experienced any flooding in the past, since it is not located within any flood plain. Storm-induced runoff will provide sheet flow toward the PFSF, which will easily be controlled by construction of short diversion berms near the southern portions of the PFSF.

Analyses of the probable maximum precipitation (PMP) were made to determine a probable maximum flood (PMF) from drainage Basins A and B (SWEC, 1999a, 1999c). As discussed in the PFSF Safety Analysis Report (SAR) Sections 2.4.2.2 and 2.4.2.3, hypothetical PMP events were analyzed to determine maximum flooding elevation at the PFSF site due to flood flows from Basin A and Basin B. The analyses included the general storm and the local storm events..

Based on the computer output, the results of the PMF are summarized in the following:

	Basin A	Basin B
$Q_{Local\ PMF}$=	40,237 cfs	68,500 cfs
$Q_{General\ PMF}$=	52,983 cfs	20,972 cfs

The larger peak discharge is selected as the PMF for the basin:

Q_{PMF}=	53,000 cfs	68,500 cfs

An extremely conservative case that is unlikely to happen in the Skull Valley drainage basin was also analyzed. In Basin A, assuming CN = 96 and Tc = 11 hours, the calculated PMF = 85,000 cfs. In Basin B, assuming CN=96, and Tc = 4.17 hours, the calculated PMF = 102,000 cfs. A CN = 96 is equivalent to an impervious surface or a saturated ground condition.

Results of hydraulic analysis indicate that maximum water surface elevation near the PFSF site is predicted to be 4,506.4 ft (upstream of the access road) in the east floodway with runoff from Basin A, and 4,478.0 ft (upstream of the rail line) in the west floodway from Basin B. Both of the predicted flood elevations are below the designed top elevations of an earthen berm (PMF berm, to be built) at 4,507.5, and 4,480 ft, respectively. Consequently, all Structures, Systems, and Components (SSCs) classified as being Important to Safety are located above the PMF flood plains.

The PFSF site drainage systems (both offsite and onsite) are designed for the 100-yr storm event. Offsite drainage system design for the Hickman Knolls runoff is conveyed around the south and west sides of the PFSF. This flow is then discharged at a permissible velocity to the natural Skull Valley drainage system. Flows resulting from a storm event more severe than a 100-year event from Hickman Knolls are also diverted into the Skull Valley drainage system. Local runoff is conveyed by a surface flow system utilizing swales channeled to a stormwater collection and detention basin where it can evaporate and seep into the soil.

The PFSF access road and the rail road drainage systems are designed to safely convey the surface water under the roadway during a 100-yr storm event. During a PMP, the excess runoff will overtop the access road and the rail road embankments. The flood overflow will be contained with a north-south berm tied into Hickman Knolls to prevent flows from approaching the PFSF. Downstream of the access road and the rail road, the PMF returns to the natural flow conditions. Access to the PFSF site by normal vehicular traffic, as well as emergency vehicles, will be provided at all times except during a storm that is more severe than a 100-yr storm event.

2.5.3 Flood Protection Requirements

As discussed in Section 2.5.2, the PFSF is not subject to flooding. Stormwater which flows toward and/or past the PFSF site area is diverted around the PFSF by newly constructed earthen berms. All structures, systems and components (SSCs) which are classified as important to safety are not subject to flooding. The earthen berms will be protected with rip rap to withstand erosion due to stormwater discharge velocities.

2.5.4 Environmental Acceptance of Effluents

There are no planned liquid releases as a result of PFSF operation. The PFSF septic system will be designed to meet state requirements. No impact to local resources will result.

2.5.5 Groundwater Hydrology

Skull Valley is a north-trending valley extending 50 miles from Lookout Pass in the Onaqui Mountains, to the southwest shore of the Great Salt Lake. It is one of many linear valleys of the Basin and Range bordered by relatively young fault-block mountains. These blocks are composed mainly of limestone and dolomite with a few beds of quartzite, sandstone, and shale, ranging in age from Early Cambrian to Tertiary. Primary permeability of these rocks is generally low; secondary permeability exists as joints, fractures, faults, and bedding plane separations.

A large portion of the precipitation that falls in the uplands runs off the steep hillsides as spring snowmelt in short, high-gradient streams, with little infiltration into the mountain blocks. Another portion drains eastward, becoming part of the hydrologic system of the adjacent Tooele and Rush valleys, while some is discharged as springs in the foothills along the edges of the valley.

Another portion enters the valley-fill aquifers through an extensive recharge area consisting of alluvial fans at the base of the ranges. Hood and Waddell (1968) estimated the long-term average annual runoff from the uplands is about 32,000 acre-ft with only a small part of this actually flowing out of Skull Valley. They estimated the average annual groundwater discharge and recharge is between 30,000 to 50,000 acre-ft with evapotranspiration accounting for 80 to 90 percent of the total discharge.

The valley-fill deposits are unconsolidated and semi-consolidated rocks of Tertiary and Quaternary age. They consist of inter-stratified colluvium, alluvium, lacustrine, and fluvial deposits with minor basalt and ash, and some eolian material. These sediments are derived almost entirely from the surrounding uplands and constitute the main groundwater reservoir.

In general, the coarser deposits are near the perimeter of the valley, grading into well-sorted sand and gravel, and interlayered with lacustrine silt and clay towards the center of the valley. Thick beds of clay exist in some areas and may create local, confined aquifers where they interfinger with sand and gravel along the alluvial fans.

The Salt Lake Group of Tertiary age comprises the majority of the valley fill ranging in thickness from 2,000 ft to over 6,000 ft (Arabasz et al., 1987). The younger Quaternary rocks deposited in Lake Bonneville are mainly silt and clay, and may be up to 1,000 ft thick in the central portion of the valley. Sack (1993) has recently mapped and described the various Quaternary and Holocene surficial deposits in Skull Valley.

The Tertiary and oldest Quaternary deposits are slightly to highly permeable, depending upon grain size and degree of cementation. The deeper, more consolidated deposits contain some volcanic deposits that may reduce the permeability. The Tertiary and Quaternary deposits probably contain most of the groundwater of usable quality in storage in this part of Utah.

The younger Quaternary and Holocene sediments in the valley bottom have generally low permeability except for areas of windblown sand and old beach and bar deposits. Precipitation on, or surface runoff to the valley bottom remains ponded until it evaporates. The precipitation that is absorbed does not reach the water table in the southern and central parts of the valley because of the depth of the water table, the low permeability of the soil materials, and the low amount of precipitation. Most of this water is captured by plants and transpired; a small portion evaporates directly through capillary action and contributes to the development of a high alkali content in the surface soils.

Groundwater flow is generally northward toward the Great Salt Lake. Hood and Waddell (1968) calculated that with a transmissivity of 2,675 ft^2/day, the annual volume of underflow out of the valley is about 800 acre-ft per year. Pumpage from wells for all purposes was estimated at 5,000 acre-ft per year in Skull Valley and is not believed to have changed significantly in the last 30 years.

Domestic water wells are developed almost exclusively in the unconsolidated alluvial fan deposits along the east side of Skull Valley. This same area serves as the main recharge area for the valley. Water quality is also the highest in this area. Discrete sand and gravel lenses are sufficiently interconnected so that water moves from bed to bed as a single hydrologic unit. Groundwater is commonly between 110 and 160 ft below ground in this area.

Farther out in the valley where lake clays have been deposited between granular layers, some degree of confinement occurs and, as a result, many irrigation and stock wells are under artesian conditions. These wells are commonly drilled to depths between 250 to 500 ft but maintain static water depth of 100 ft or less (Figure 2.5-2). Some well records indicate artesian flow at the ground surface from wells just south of the Skull Valley Indian Reservation. This information dates from the 1940's to 1960's (Arabasz et al., 1987).

Groundwater quality varies significantly in Skull Valley, dependent mainly on proximity to the bordering ranges. The alluvial apron along the base of the Stansbury Mountains contains the lowest total dissolved solids (TDS) in the valley, with concentrations from 100 to 800 mg/l. In the southernmost part of the valley, TDS concentrations range from

700 to about 900 mg/l with a few isolated wells above 1,000 mg/l TDS. A well south of the Skull Valley Indian Reservation yielded a TDS concentration of greater than 2,500 mg/l (Arabasz et al., 1987). Sodium and chloride are the major ions found in these waters.

Toward the center part of the valley, away from the alluvial apron, unconsolidated lacustrine materials are interstratified with clastic material. Wells in this area tend to have lower yields and poorer quality water (TDS >1,000 mg/l) and are used mainly for irrigation and stock watering. The north end of the valley has generally high TDS concentrations, in the range of 1,600 to 7,900 mg/l with sodium and chloride again being the main constituents (Arabasz et al., 1987).

Based on boring data obtained at the PFSF site, the uppermost soil layer consists of interbedded silt, silty clay, and clayey silt with a thickness of approximately 30 ft. This layer is underlain by very dense fine sand and silt. The groundwater table was encountered in the borings at a depth of 125 ft (approximate elevation 4,350 ft).

Limited hydraulic characteristics of the soil in the PFSF vicinity are available from the on-site boring program (SWEC, 1999b).

The hydraulic gradient was estimated to be approximately 9.5×10^{-4}. (Hood and Waddell, 1968). Groundwater flows in a south to north direction toward the Great Salt Lake.

Soil interpretations prepared by USDA (undated) indicate that the permeability of a silt soil in Skull Valley ranges from 0.2 to 0.6 inch/hr. The average groundwater velocity was estimated to be approximately 2.8×10^{-3} to 8.5×10^{-3} gallons/day/sq ft.

The source of groundwater flow at the PFSF is mainly derived from precipitation that falls at the higher elevations of the Stansbury and Cedar Mountains. As a result of the low permeability deposits and high evapotranspiration at the PFSF, rainfall at the PFSF is unlikely to contribute to groundwater flow.

Initial testing of the onsite groundwater monitoring well indicates that development of the PFSF will have no measurable offsite effects on existing groundwater quality or levels of a water supply well at the site (SWEC, 1999b).

2.5.6 Contaminant Transport Analysis

The nature and form of the material stored (spent fuel rod assemblies) and the method of storage (dry casks) preclude the possibility of a liquid contaminant spill. Discussion of potential contamination of groundwater is not applicable.