APPENDIX E

SPILL RISK ASSESSMENT INFORMATION

APPENDIX E
NATURAL GAS CONDENSATE RISK ASSESSMENT FOR FISHERIES

Most producing wells in the Inland project area would be associated with 2- to 6-inch diameter poly pipes carrying natural gas and natural gas condensate. If the pipelines were to leak or rupture, there would be a possibility that condensate could drain into nearby dry washes and perennial stream bottoms. These channels could carry spilled natural gas condensate into lower Pariette Wash and into the Green River.

Federal agencies have expressed concerns for federally-protected fish species in the Green River if a spill were to occur. Consequently, a risk assessment was conducted to evaluate the potential risk to these aquatic species from a release of natural gas condensate into these washes and stream bottoms.

For fish and aquatic biota in the Green River, risk of adverse effects is a function of: 1) the chance of exposure and 2) the concentration of the contaminant that could occur within the river as the result of a spill. Both of these factors were evaluated to determine the likelihood of adverse effects to endangered fish and other aquatic biota in the Green River.

E.1 Background

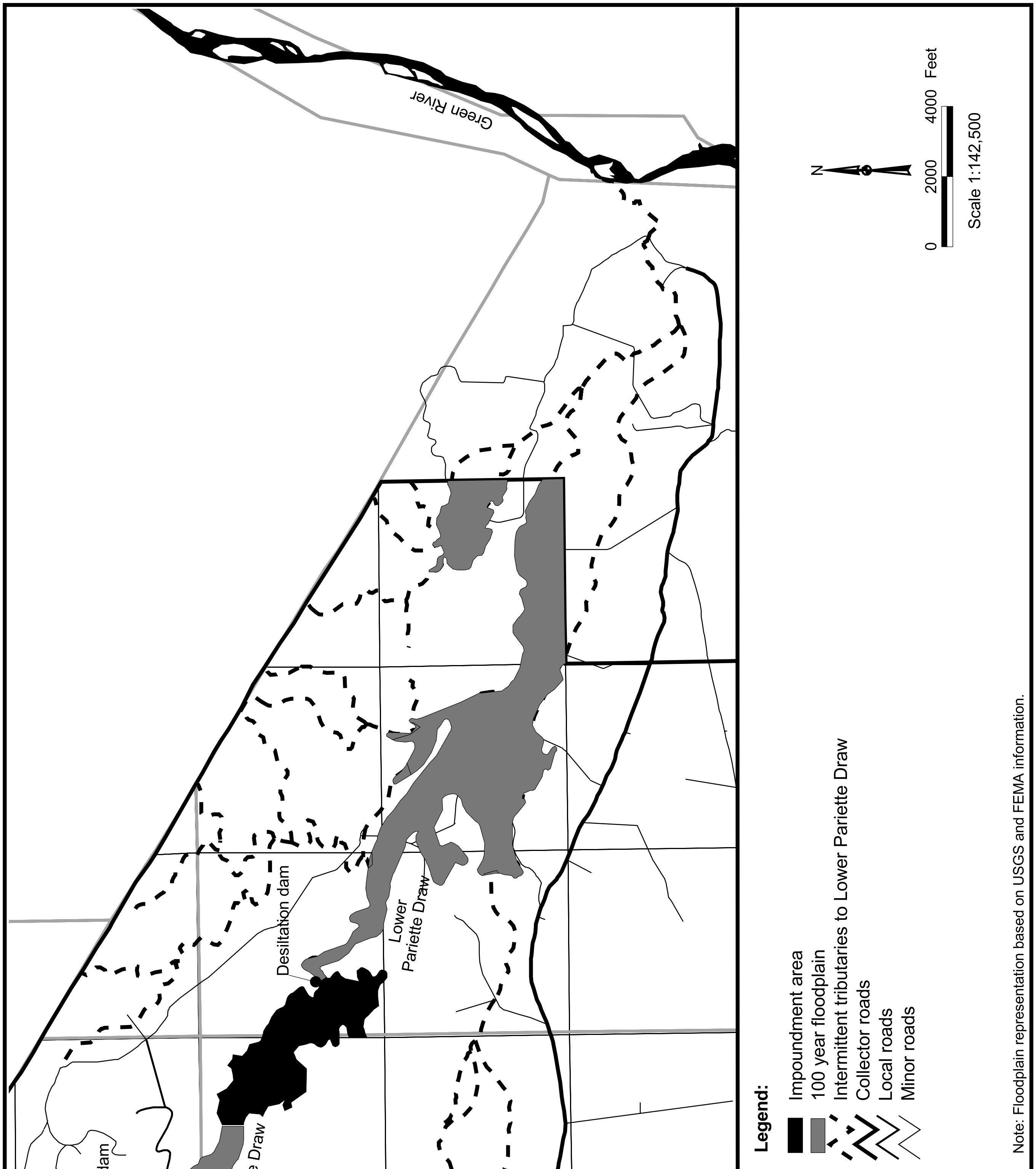
For most of the wells and their pipelines, substantial amounts of condensate would be unlikely to reach the Green River given the sizable overland distance between the pipeline and stream bottoms and the high evaporation rate of the condensate. For this analysis, it was assumed that appreciable quantities of condensate would be unable to reach the wash that was greater than 0.1 mile away.

The Inland project area can be roughly divided into three separate areas: 1) areas that drain into upper Pariette Draw (above the desiltation dam); 2) lower Pariette Draw (below the detention and desiltation dam); and 3) Sheep Wash (**Figure E-1**).

E.1.1 Upper Pariette Draw

In the project area, much of the watershed (e.g., Castle Peak Draw and many unnamed washes) drains directly into upper Pariette Draw, located above the detention and desiltation dams. Stream flow in upper Pariette Draw tributaries often is intermittent and becomes perennial as the washes near the dams. When completely dry, the two dams take about a week to fill (Faircloth 2003). When full, it is estimated these ponds typically retain water for a minimum of 1 day before water reaches the Green River. Below the dams, stream flow in Pariette Draw travels 4 miles before emptying into the Green River.

While flannelmouth sucker larvae historically have utilized Pariette Draw as habitat, Pariette Draw currently is dry, and a dam prevents the upstream movement of fish from the Green River into Pariette Draw. Flannelmouth sucker larvae may have previously colonized Pariette Draw using irrigation canals as conduits. Since agricultural practices in the area recently have changed, the canals are not used at this time. Consequently, flannelmouth suckers and threatened and endangered fish species are not expected to inhabit Pariette Draw.



Castle Peak and Eightmile Flat Oil and Gas Expansion Project

Figure E-1

Floodplain and Intermittent Tributaries to Lower Pariette Draw

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E.1.2 Lower Pariette Draw

Lower Pariette Draw is located below the desiltation and detention dams. Tributaries leading into lower Pariette Draw are intermittent, while flow in lower Pariette Draw is perennial. Stream flow within this small drainage would not be detained by disiltation and detention dams before entering the Green River. As a result, a release of condensate within the 100-year floodplain of Pariette Draw potentially could reach the Green River with only minor attenuation.

As described above for upper Pariette Draw, flannelmouth sucker larvae historically have utilized lower Pariette Draw as habitat, but a dam prevents the upstream movement of fish from the Green River into Pariette Draw. Given the current agricultural practices, recolonization of lower Pariette Draw by flannelmouth sucker larvae is not anticipated.

Lower Pariette Draw also contains riparian habitat as well as several ponds and wetlands. While dry at this time, these ponds often contain aquatic and semi-aquatic species.

The confluence of Pariette Draw and the Green River is an important rearing habitat for several threatened and endangered fish species and their young during periods of high flow.

E.1.3 Sheep Wash

Sheep Wash watershed (also known as Eightmile Flat watershed), drains the southeastern portion of the project area (see **Figure 3.1-1**). While there is no perennial water in this drainage, any intermittent flow in Sheep Wash would drain into the Green River. While there are no detention dams along this drainage, there is a pond located near the confluence with the Green River. Under most conditions, this pond would increase the length of time it would take for condensate to travel from Sheep Wash into the Green River.

The confluence of Pariette Draw and the Green River, identified as an important rearing habitat for several threatened and endangered fish species and their young during periods of high flow, is located immediately upstream of the mouth of Sheep Wash. Consequently, larval fish also may use this area as rearing habitat during periods of high flow.

E.2 Toxicity Assessment

In order to estimate the potential concentration of natural gas condensate reaching aquatic biota in lower Pariette Draw or the Green River from the pipelines associated with most well pads, conservative-assumptions (i.e., assumptions that are most likely to show an adverse effect) were made.
If the results of this screening-level exposure assessment suggested the potential for toxicity, more realistic and less highly conservative assumptions could be made to further refine the assessment. Furthermore, the results from the screening risk assessment should be coupled with the exposure assessment (see Section E.3), which calculates the likelihood of a spill reaching lower Pariette Draw or the Green River in sufficient quantities to cause toxicity. However, if the screening assessment indicates minimal risk to aquatic species, then it can be concluded that adverse effects are unlikely, regardless of conditions.

Assumptions Included:

1) The overland distance that condensate could be reasonably expected to traverse from a pipeline to a wash was estimated to be 0.2 mile (0.1 mile on either side of the wash).

2) The locations of small natural gas/condensate pipelines are not known at this time. For this analysis, it was assumed that the maximum draindown distance of a pipeline (the distance of pipeline that could drain into the environment if a rupture were to occur) was estimated to be 1.5 mile.

3) The entire draindown volume was assumed to enter a wash leading to Pariette Draw and/or the Green River. The assumption of 100 percent draindown is highly conservative. Research has shown that in only 6 percent of the historical spills did the actual draindown volumes account for as much as 50 percent of the potential draindown volume (CSFM 1993). In 80 percent of pipeline spills, the volume released was less than 8.5 percent of the total volume in the pipe.

4) Small diameter natural gas condensate pipelines would not be routinely pigged to remove condensate. Based on a 1.5-mile draindown distance for a 3-inch pipeline and assuming complete draindown, the release volume would be about 2,600 gallons.

5) If a small natural gas condensate pipeline crosses or is within 0.1 mile of an intermittent wash that drains to lower Pariette Draw (see **Figure 4.2-2**), condensate would be able to reach the wash. Pipeline ruptures beyond 0.1 mile of a wash would evaporate before a substantial fraction could reach a wash.

6) Approximately 85 percent of the natural gas liquids spilled would be natural gas condensate, and the remainder would be water. (This worst-case assumption was used for risk assessment in the Saddletree Draw EA, UTU-76880.) For a 3-inch pipeline with a total release volume of 2,600 gallons, the natural gas liquids release would contain about 2,200 gallons of condensate.

7) To maximize concentrations in Pariette Draw and/or the Green River, it was assumed that 100 percent of the natural gas condensate spilled into a wash would reach Pariette Draw or the Green River without natural attenuation or breakdown of the natural gas condensate.

8) Natural gas condensate contains a variety of lightweight hydrocarbons (**Table E-1**). Of these, the most toxic constituent to aquatic biota is the aromatic hydrocarbon fraction (BETX), which would account for less than 0.5 percent of the volume of spilled material. For this screening assessment, acute toxicity was evaluated assuming the condensate consisted of twice the expected aromatic hydrocarbon concentration (i.e., 1 percent) and that the aromatic hydrocarbons were entirely solubilized within the water column.

Table E-1
Chemical Composition of Inland's Natural Gas Condensate

Liquid Components	Carbon Content	Percent of Total Spilled Volume	Residence Time
Ethane	C2	0[1]	Immediately becomes gas.
Propane	C3	0[1]	Immediately becomes gas.
Butanes	C4	0[1]	Immediately becomes gas.
Pentanes	C5	71	Less than 8 hours.
N-Hexane	C6	5	Less than 8 hours.
Benzene	C6	0.3	Less than 8 hours.
Toluene	C7	0.1	Less than 8 hours.
Ethylbenzene	C8	0.04	Less than 8 hours.
Xylenes	C8	0.03	Less than 8 hours.
Other paraffins[2]	C10 - C12	23	10 days or less.

[1]While present in the pipeline as a liquid, the component immediately becomes gas upon release. As a result, the component is not considered as part of the spilled volume.
[2]Chemical analysis of condensate found no hydrocarbons larger than C12.

9) Adverse effects associated with lightweight hydrocarbons in natural gas condensate would be limited to acute toxicity (i.e., mortality). Chronic effects were not evaluated since any condensate that would reach the river would have a short residence time in any single location due to rapid evaporation and downstream transport. Larger, straight-chained paraffins (C10 to C12 hydrocarbons) that may persist for more than a day are relatively insoluble and have low toxicity to aquatic species (NAS 1975; Robotham and Gill 1989). Since the residence time for potential contamination would be short (i.e., minutes to hours) within the Green River and chronic toxicity would require exposure for a longer period (i.e., weeks to months), it is reasonable to assume chronic toxicity would not be an issue.

The acute toxicity threshold for aromatic hydrocarbons was set at 7.4 ppm, based on the toxicity of benzene. This value was the lowest acute toxicity value for aromatic hydrocarbons for freshwater fish, invertebrates, and algae cited in the USEPA's toxicity database (AQUIRE 1998). This acute toxicity threshold value would be protective of endangered fish species and other aquatic biota. To allow direct comparison with this value, concentrations of aromatic hydrocarbons within the Pariette Draw and Green River were calculated over a 96-hour exposure period, a timeframe equivalent to the duration of the acute exposure threshold value.

E.2.1 Upper Pariette Draw

Once released into the environment, evaporation and other attenuation mechanisms immediately would begin to reduce the spill volume after natural gas condensate was released into the environment. Based on the chemical composition of the natural gas condensate that would be produced by Inland, it is estimated that the majority of the released material would evaporate within 8 hours (**Table E-1**).

Once the condensate reached the perennial reaches of upper Pariette Draw, the intervening detention and desiltation dams along the Pariette Draw drainage would intercept floodwaters and any associated condensate prior to reaching important fish habitat in the lower Pariette Draw and its confluence with the Green River. The detention and desiltation dams would increase travel time and enhance evaporative losses as the condensate spread across the water's surface. The amount of condensate that would reach the Green River would be reduced in proportion to its increased travel time. If the travel time reached 8 hours or more, the amount of condensate reaching lower Pariette Draw or the Green River would be negligible and acute toxicity would not be anticipated in either location.

The areas behind the detention and desiltation dams in upper Pariette Draw are often dry; most semi-permanent aquatic habitat is located in lower Pariette Draw and its confluence with the Green River. As a result, ephemeral contamination within the detention and desiltation dams would be unlikely to markedly affect aquatic populations.

E.2.2 Lower Pariette Draw

Based on USGS gaging data (USGS station 09307300, Pariette Draw at mouth near Ouray, Utah), Pariette Draw streams discharge data for 9 years (from 1975 to 1984) was statistically summarized (**Table E-2**). Concentrations of aromatic hydrocarbons were calculated for a range of discharge rates, including the minimum-recorded streamflow and low flow.

Table E-2
Comparison of the Estimated Aromatic Hydrocarbon Concentrations in Lower Pariette Draw with Acute Toxicity Threshold Value (7.4 ppm)
Based On A Release in Lower Pariette Draw

Pariette Draw Discharge Rates	Streamflow (cfs)	Estimated Aromatic Hydrocarbon Concentration in Pariette Draw (ppm)	Exceeds Toxicity Threshold (7.4 ppm)
Minimum Recorded	0	---	Yes
Low	4	157	Yes
Median	15	39	Yes
High	53	11	Yes

Note: Estimated concentrations in Pariette Draw based on a 2,200-gallon spill containing 1 percent aromatic hydrocarbons, which completely solubilizes and uniformly disperses throughout the entire water column.

Based on the conservative assumptions described in Section E.2, Toxicity Assessment, the concentrations of aromatic hydrocarbons in Pariette Draw were calculated (**Table E-2**). The estimated concentrations of aromatic hydrocarbons were found to exceed the acute toxicity threshold, regardless of flow.

In contrast to upper Pariette Draw, a release that empties into lower Pariette Draw has greater potential for acute toxicity and its consequences would be more significant than for a release into upper Pariette Draw. Because of the absence of the detention and desiltation dams, condensate would not attenuate to any

appreciable extent. During periods of low flow, aquatic and semi-aquatic biota occupying lower Pariette Draw potentially could be exposed to toxic concentrations as summarized in **Table E-2**.

An alternative evaluation method to estimate the potential for toxicity to aquatic biota in lower Pariette Draw is to estimate the volume of condensate that would be necessary to cause acute toxicity. Based on a stream flow of 4 cfs (low flow conditions), about 112 gallons of condensate would result in an exceedance of the acute toxicity threshold. This amount of condensate could be contained within a 0.5-mile segment of a 3-inch pipeline filled with 5 percent condensate. The potential for these impacts could be minimized through implementation of mitigation measures WFM-5, WFM-6, WFM-7, and WFM-8 as discussed in Section E.4, Mitigation Effectiveness.

E.2.3 Green River

Using USGS gaging data (USGS station 09261000, Green River near Jensen, Utah), Green River stream discharge data over the past 20 years was statistically summarized. Concentrations of aromatic hydrocarbons were calculated for a range of discharge rates.

Based on a release of condensate in Sheep Wash drainage, concentrations of aromatic hydrocarbons in the Green River were calculated in **Table E-3**. The estimated concentration of aromatic hydrocarbons in the Green River would be more than 10 times lower than the acute toxicity threshold, regardless of flow conditions (**Table E-3**). These results indicate that the probability of acute toxicity in the mainstem of the Green River would be low.

Table E-3
Comparison of the Estimated Aromatic Hydrocarbon Concentrations in the Green River with Acute Toxicity Threshold Value (7.4 ppm)

Green River Discharge Rates	Streamflow (cfs)	Estimated Aromatic Hydrocarbon Concentration in Green River (ppm)	Exceeds Toxicity Threshold (7.4 ppm)
Minimum Recorded	828	0.7	No
Low	1,330	0.4	No
Median	2,640	0.2	No
High	9,234	0.06	No

Note: Estimated concentrations in the Green River based on a 2,200-gallon spill containing 1 percent aromatic hydrocarbons, which completely solubilizes and uniformly disperses throughout the entire water column.

Because the tributaries in Sheep Wash drainage are intermittent streams, condensate would not be transported downstream in the absence of a storm event. The likelihood of a storm event coinciding with a release is evaluated in the exposure assessment presented in Section E.3.

If stream flow should be present in the Sheep Wash drainage during a spill event, the pond near Sheep Wash's confluence with the Green River would detain condensate under most conditions. If an exceptionally

large flow event quickly transported condensate beyond the pond to the Green River, the condensate would be diluted by the streamflow and, again, toxicity in the Green River would not be anticipated.

Concentrations in **Table E-3** do not completely eliminate the possibility of localized toxicity at the confluence of the Green River with Pariette Draw or Sheep Wash. If a release were to occur in lower Pariette Draw or if storm waters allowed a release into Sheep Wash to bypass the pond, condensate potentially could reach the Green River with only minor attenuation. Aquatic biota in backwater areas would experience higher concentrations of the condensate than in the main river channel. Nevertheless, the potential for adverse effects would be moderated by downstream transport and rapid attenuation that quickly would reduce exposure concentrations and substantially limit exposure duration. Additionally, though this portion of the Green River is used as rearing habitat for threatened and endangered fish species, the area primarily is used during high flows when dilution effects would be greatest. Thus, condensate releases to either Pariette Draw or Sheep Wash drainages would not pose a major threat to aquatic biota in the Green River.

E.3 Exposure Assessment

The risk to aquatic biota is a function of the toxicity of the compound as well as the likelihood of exposure. This section evaluates the probability of condensate reaching areas containing aquatic biota.

Most spills would not enter a stream channel due to the distance the condensate must travel overland and the rapid evaporation rate of the condensate. For this assessment, it was assumed that a release within 0.1 mile of a wash (a combined distance of 0.2 mile for both stream banks) potentially could enter the drainage and be transported downstream (see Assumption #1 in Section E.2).

E.3.1 Upper Pariette Draw

While the locations and mileage of natural gas pipelines in areas that drain into upper Pariette Draw are unknown at this time, these pipelines are unlikely to cause toxicity due to the residence time anticipated in impoundments behind the detention and desiltation dams. Consequently, the likelihood of exposure in the Green River was not evaluated.

E.3.2 Lower Pariette Draw

Under the Proposed Action, new natural gas condensate pipelines could be located within the 100-year floodplain of lower Pariette Draw and new natural gas condensate pipelines could cross the lower Pariette Draw stream channel. For the purposes of calculating exposure risk, a total of 5.0 miles of natural gas condensate pipeline was assumed within the 100-year floodplain. These pipelines would not be routinely pigged and could contain up to 35 percent natural gas liquids. If a 3-inch pipeline within the 100-year floodplain were to rupture and the entire draindown volume was released for 1.5 miles, acute toxicity would be predicted under all flow conditions.

Based on historical national averages for pipeline incidents (0.001 incidents/mile per year; calculated from data in OPS 2002), a pipeline release in the 100-year floodplain would be predicted to occur once every 300 years (= 1/[0.001 spills/mile per year x 3 miles]).

Outside of the 100-year floodplain, there are only a few drainages that empty into lower Pariette Draw; most of the project area drains into upper Pariette Draw and a lesser amount drains into the Sheep Wash drainage. The drainages that empty into lower Pariette Draw are shown in **Figure 3.1-2**. For this assessment, it is assumed that 40 crossings of tributary washes could be needed. This would result in 8 miles of pipeline within 0.1 mile of tributary washes (8 miles = 40 crossings x 0.2 mile per crossing [both sides of the wash]).

Using national averages for pipeline incidents as described previously, the chance of a release into tributaries of lower Pariette Draw would be once in 125 years. Since all tributaries to lower Pariette Draw are intermittent, a storm event would have to occur in order for condensate to be transported downstream to lower Pariette Draw. Given the volatility of the condensate, a rainstorm would need to coincide within a few hours of the spill, otherwise the vast majority of the spilled material would have already evaporated. A storm event of sufficient size to transport the condensate downstream to lower Pariette Draw would likely occur no more than 10 percent of the time. When the chance of a pipeline release is combined with the chance of a storm event capable of reaching lower Pariette Draw, the chances of condensate reaching lower Pariette Draw and then the Green River is once in 1,250 years (= 125 years/10 percent).

The combined probability of a spill in either the 100-year floodplain or outside of the floodplain in lower Pariette Draw is once in 90 years.

Since larvae of threatened and endangered fish species are present at the confluence of Pariette Draw and the Green River only during very high flows (10 percent of the time), the chance of fish being present during a spill would be once in 900 years (= 90 years/10 percent).

E.3.3 Green River

The likelihood of a spill event capable of reaching the Green River would be moderately low (once in 900 years), since the larval fish utilize the confluence of Pariette Draw and the Green River only during high flows. If such an event were to occur, the event would be unlikely to cause adverse effects to aquatic biota since the conservatively estimated concentrations in the Green River did not exceed toxic thresholds, regardless of streamflows and presumed maximum draindown volume (**Table E-3**). Thus, risk to fish in the Green River would be low under the Proposed Action.

E.4 Mitigation Measures

The following mitigation measures would minimize potential spill-related effects (toxic concentration of condensate in lower Pariette Draw) to threatened and endangered fish species, and have been incorporated into Alternative A.

WFM-5. No pipeline containing natural gas condensate would cross the Pariette Draw stream channel downstream of the desiltation dam.

WFM-6. Natural gas condensate pipelines that cross the FEMA-mapped 100-year floodplain, mapped riparian, or wetland areas in lower Pariette Draw will be routinely pigged to ensure that the pipeline contains no more than 125 gallons of natural gas liquids per 0.5 mile of pipe. Lower Pariette Draw is defined as the portion of Pariette Draw located between the foot of the Pariette Draw desiltation dam and the confluence of Pariette Draw and the Green River.

WFM-7. Natural gas condensate pipelines will be located at least 0.1 mile away from stream channels and washes that directly lead into lower Pariette Draw. Where crossings of these tributaries to lower Pariette Draw are necessary to minimize pipeline length, these pipelines will be pigged as described in WFM-6.

WFM–8. Natural gas pipelines that cross perennial, intermittent, and ephemeral stream channels will either be elevated above the predicted 100-year flood event on a pipe bridge, or buried below the predicted scour depth for an equivalent flood event. The construction requirements for each type of crossing will be determined on a site-specific basis, and will consider the technical guidance of the paper entitled *Hydraulic Considerations for Pipeline Crossings of Stream Crossings* (BLM 2003).

E.5 Mitigation Effectiveness

E.5.1 Upper Pariette Draw

The mitigation measures would not affect the chance of a spill event or its consequences in upper Pariette Draw.

E.5.2 Lower Pariette Draw

With implementation of mitigation measures WFM-6 and WFM-7, natural gas condensate pipelines located within the 100-year floodplain of lower Pariette Draw and its tributaries would be routinely pigged so that the pipelines would contain no more than 125 gallons of natural gas liquids per 0.5 mile of pipe. As a result, a 3-inch pipeline would contain 5 percent liquids or less. If a 3-inch natural gas condensate pipeline contained 5 percent liquids within the 1.5-mile draindown distance, the maximum draindown volume of natural gas liquids that could be released into a wash by one pipeline at any one time would be approximately 370 gallons. Since natural gas liquids would contain 15 percent water, and based on a total release volume of 370 gallons, an estimated 310 gallons of natural gas condensate could be released into lower Pariette Draw.

The implementation of mitigation measures would reduce the exposure risk to biota in lower Pariette Draw. With implementation of mitigation measure WFM-5, the construction of new natural gas condensate pipelines across the stream channels in lower Pariette Draw would be prohibited. Under this scenario, Inland likely would reduce the number of pipeline crossings for lower Pariette Draw and its tributary washes in order to reduce the number of pipelines that would require routine pigging (Mitigation Measures WFM-6 and WFM-7). Reducing the number of pipelines would decrease the risk of condensate being released into lower Pariette Draw. Based on the conservative assumptions described above, the potential concentrations of aromatic hydrocarbons in lower Pariette Draw as a result of a spill were calculated (see **Table E-4**).

Implementation of mitigation measures WFM-5, WFM-6, WFM-7, and WFM-8 would result in few new natural gas condensate pipelines, if any, being located within the 100-year floodplain of lower Pariette Draw and would require pigging of pipelines that would be built in this area. No new natural gas condensate pipelines would cross the lower Pariette Draw stream channel. For the purposes of calculating exposure risk, a total of 1 mile of natural gas condensate pipelines within lower Pariette Draw's 100-year floodplain was assumed. If these pipelines were present, these lines would be routinely pigged so that the pipeline would contain no more than 125 gallons of natural gas liquids per 0.5 mile of pipe (WFM-6 and WFM-7). If a pipeline within the 100-year floodplain were to rupture, enter perennial water, and the entire draindown volume was released for 1.5 miles, the estimated concentrations of aromatic hydrocarbons would be below the toxicity threshold; acute toxicity would be predicted only under low flow conditions. Thus, measures WFM-5, WFM-6, and WFM-7 would quantitatively reduce the potential for toxic effects to aquatic biota in lower Pariette Draw.

Table E-4
Comparison of the Estimated Aromatic Hydrocarbon Concentrations in Lower Pariette Draw with Acute Toxicity Threshold Value (7.4 ppm) Based on the Implementation of Mitigation Measures

Pariette Draw Discharge Rates	Streamflow (cfs)	Estimated Aromatic Hydrocarbon Concentration in Pariette Draw (ppm)	Exceeds Toxicity Threshold (7.4 ppm)
Minimum Recorded	0	---	Yes
Low	4	22	Yes
Median	15	5	No
High	53	2	No

Note: Estimated concentrations in Pariette Draw based on a 310-gallon spill containing 1 percent aromatic hydrocarbons, which completely solubilizes and uniformly disperses throughout the entire water column.

Based on historical national averages for pipeline incidents (0.001 incidents/mile per year; calculated from data in OPS 2002), a pipeline release in lower Pariette Draw would be predicted to occur once every 1,000 years (= 1/[0.001 spills/mile per year x 1 miles] when mitigation is applied). When combined with the chance of a low flow event, the chances of condensate exceeding the acute toxicity threshold from a pipeline located in lower Pariette Draw is once in 10,000 years when mitigation is applied.

Outside of the 100-year floodplain, there are only a few drainages that empty into lower Pariette Draw; most of the project area drains into upper Pariette Draw and a lesser amount drains into the Sheep Wash drainage. The drainages that empty into lower Pariette Draw are shown in **Figure 3.1-2**. With implementation of mitigation measures WFM-5, WFM-6, WFM-7, and WFM-8 the number of pipeline crossings for tributary washes to lower Pariette Draw likely would be limited to reduce the number of lines that would need to be pigged. For this assessment, it was conservatively assumed that 20 crossings of Pariette Draw could be needed. This would result in 4 miles of pipeline within 0.1 mile of tributary washes (4 miles = 20 crossings x 0.2 miles per crossing [both sides of the wash]).

Using national averages for pipeline incidents as described previously, the chance of a release into tributaries of lower Pariette Draw would be once in 250 years when mitigation is applied. Since all tributaries to lower Pariette Draw are intermittent, a storm event would have to occur in order for condensate to be transported downstream to lower Pariette Draw. Given the volatility of the condensate, a rainstorm would need to coincide within a few hours of the spill, otherwise the majority of the spilled material would have already evaporated. A storm event of sufficient size to transport the condensate downstream to lower Pariette Draw would likely occur no more than 10 percent of the time. When the chance of a pipeline release is combined with the chance of a storm event capable of reaching lower Pariette Draw, the chances of condensate reaching lower Pariette Draw and then the Green River is once in 2,500 years (=250 years/10 percent). When combined with the chance of a low flow event (the only flow regime where toxicity is predicted), the chances of condensate exceeding the acute toxicity threshold from a pipeline located outside of the 100-year floodplain of lower Pariette Draw is once in 25,000 years when mitigation is applied.

The combined probability of a spill in either the 100-year floodplain or outside of the floodplain in lower Pariette Draw is once in over 7,100 years when mitigation is applied.

Since larvae of threatened and endangered fish are present at the confluence of Pariette Draw and the Green River only during very high flows (10 percent of the time), the chance of fish being present during a spill would be once in 71,000 years (= 7,100 years/10 percent) when mitigation is applied.

Compared to the Proposed Action where toxic concentrations could occur in lower Pariette Draw as frequently as once in 90 years, the probability of such an event following the implementation of mitigation measures would reduce the likelihood to once in 7,100 years. Green River fish could be exposed to toxic concentrations as frequently as once in 900 years under the Proposed Action, but the risk would be reduced to once in 71,000 years with the implementation of the mitigation measures. Thus, the mitigation measures would reduce the risk of exposure to Green River fish.

E.5.3 Green River

Since mitigation measures would not apply to the Sheep Wash drainage, concentrations of condensate that could reach the Green River via Sheep Wash, assuming zero detention in the pond in Sheep Wash, would be the same as those described previously for the Green River in Section E.2.3.

Implementation of mitigation measures along lower Pariette Draw would markedly reduce the amount of condensate that could reach lower Pariette Draw. With implementation of mitigation, the estimated concentration of aromatic hydrocarbons in the Green River would be more than 70 times lower than the acute toxicity threshold, regardless of flow conditions. These results indicate that the implementation of mitigation measures in lower Pariette Draw would quantitatively reduce the potential for toxicity in the Green River.

Because concentrations of condensate that could occur if mitigation is implemented (**Table E-5)** would be well below acute toxicity thresholds, localized toxicity at the confluence of the Green River with Pariette Draw would not be anticipated.

Implementation of measures WFM-5, WFM-6, WFM-7, and WFM-8 also would reduce the exposure risk to biota in the Green River. By reducing the likelihood of a spill event in lower Pariette Draw, the chance of a spill reaching the Green River is proportionally decreased. If mitigation is implemented, the likelihood of a spill event capable of reaching the Green River while larval fish were present would be remote (once in 71,000 years). Compared to the risk of exposure under the Proposed Action (once in 900 years), the implementation of mitigation measures substantially reduces the exposure hazard.

Table E-5
Comparison of the Estimated Aromatic Hydrocarbon Concentrations in Green River with Acute Toxicity Threshold Value (7.4 ppm) Following the Implementation of Mitigation Measures.

Green River Discharge Rates	Streamflow (cfs)	Estimated Aromatic Hydrocarbon Concentration in Green River (ppm)	Exceeds Toxicity Threshold (7.4 ppm)
Minimum Recorded	828	0.1	No
Low	1,330	0.06	No
Median	2,640	0.03	No
High	9,234	0.009	No

Note: Estimated concentrations in the Green River based on a 310-gallon spill containing 1 percent aromatic hydrocarbons, which completely solubilizes and uniformly disperses throughout the entire water column.

E.6 Risk Assessment Summary

This assessment evaluated the risk of toxic effects on endangered fish species of the Green River. Spills that would drain into upper Pariette Draw were not considered to be a risk to Green River fish due to the presence of detention and desiltation dams. These dams would prevent condensate from reaching the Green River before the condensate evaporated. Similarly, releases within the Sheep Wash drainage would be retained by a pond before reaching the Green River, so toxicity in the Green River would not be anticipated. In contrast, dams would not retain spills in lower Pariette Draw and its tributaries. As a result, aquatic biota in lower Pariette Draw could experience acute toxicity in the event of a spill. The chance of a release reaching lower Pariette Draw at sufficient concentrations to cause acute toxicity within Pariette Draw would be once in 90 years under the Proposed Action, or once in 7,100 years with implementation of mitigation measures. Finally, if a spill occurred in lower Pariette Draw and was transported to the Green River, the concentration of the condensate would be at least 10 times lower than the acute toxicity threshold. Since threatened and endangered fish larvae utilize the confluence of Pariette Draw and the Green River only during very high flows, the chance of these fish being present during a spill would be once in 900 years under the Proposed Action, or once in 71,000 years with implementation of mitigation measures. Overall, the possibility of adverse effects to aquatic biota in the Green River would be very low.

E.6.1 Residual Impacts

The potential for appreciable amounts of condensate to reach the Green River is very low. If condensate were to reach the river, the concentrations are expected to be below acute toxicity levels. Consequently, the likelihood of adverse effects to special status species would be very low.

E.6.2 Cumulative Impacts

Given that the probability of a pipeline release and the predicted magnitude of impacts are remote, unmitigated or unavoidable adverse impacts to special status fish species from the Proposed Action would have minimal cumulative impacts.

There is the potential that fish may be directly and indirectly affected from other oil and gas spills from other nearby pipelines. The risk posed by each pipeline depends primarily on the pipeline's diameter, the type of pipe material, the type of product transported, likely spill volume size, and its distance to the Green River. Since each new pipeline that crosses a wash contributes to the potential for adverse effects on endangered fish and other aquatic fauna, cumulative risk of additional natural gas condensate pipelines to risk posed by existing pipelines was evaluated. The analysis follows the same assumptions described above.

At this time, there are a number of existing, small diameter, natural gas condensate pipelines. These pipelines are associated with the No Action Alternative. Risk from these pipelines would be the same or higher than described for the Proposed Action, since existing pipelines located within the project area are not necessarily routinely pigged. Consequently, existing small diameter pipelines could release condensate to the environment.

In addition to small-diameter pipelines, there is an existing 10-inch natural gas condensate transmission pipeline. Another 10-inch transmission natural gas/condensate pipeline would be built (Inland 2004) and this pipeline would transport much of the material already carried by the existing pipeline (i.e., no net increase in condensate transported by these 10-inch pipelines). Releases from these two pipelines would drain into upper Pariette Draw; however, they are not expected to pose a significant threat to fish in the Green River (BLM 2003b, Inland 2004).

Increasing the overall miles of pipelines in the area markedly increases the amount of condensate that could be released into the environment. More pipelines would increase the probability that a release could occur somewhere within the project area. Additionally, more pipelines also would increase the total volume of condensate within the pipeline system. A rupture of more than one pipeline rapidly would increase the likelihood of toxicity to downstream receptors. Mitigation measures WFM-5, WFM-6, WFM-7, and WFM-8 would reduce the amount of new pipelines built within lower Pariette Draw and would require pigging of pipelines that would be built in this area. Through the risk assessment process, this area was identified as the most susceptible area. Mitigation measures WFM-7 and WFM-8 likely would reduce the number of tributary crossings, and therefore would reduce the chance of exposure.

In most circumstances, pipeline ruptures are largely independent events (i.e., the rupture of one small pipeline does not generally cause the rupture of another pipeline). However, flooding and vandalism are

examples of events that could result in multiple pipeline failures. Historical data from the Office of Pipeline Safety suggest that only 2 percent of pipeline failures can be attributed to natural forces, including flooding (NTSB 1996). Similar statistics are unavailable for vandalism, but are expected to be relatively low.

In total, increasing the amount of natural gas condensate pipelines in the project area, particularly in areas draining directly into lower Pariette Draw, increases the potential hazard to Green River fish. Since the mileage of existing and proposed pipe is unknown, the increased risk cannot be quantified. However, the chance of two or more pipelines independently failing at the same time would be extremely remote, roughly once in 1 million years (=1/(0.001 incidents/mile per year x 0.001 incidents/mile per year). The chance for a flood to break two or more pipelines in lower Pariette Draw is calculated to be once in 10,000 years (=1/(0.001 incidents/mile per year x 5 miles x 2 percent chance). The risk of vandalism rupturing 2 or more pipes is unknown, but also is expected to be low. Consequently, while cumulative impacts to aquatic biota in the Green River from natural gas condensate spills could occur, the chance of multiple pipelines rupturing is estimated to be once in at least 10,000 years.