

1 **4.4 Nebraska-South Dakota-Wyoming Uranium Milling Region**

2
3 **4.4.1 Land Use Impacts**

4
5 Information on ISL facility size (Section 2.11) and the types of potential impacts to land use
6 previously described for the two Wyoming regions (see Sections 4.2.1 and 4.3.1) would also
7 generally apply for ISL facilities in the Nebraska-South Dakota-Wyoming Uranium
8 Milling Region.

9
10 **4.4.1.1 Construction Impacts to Land Use**

11
12 The overall land uses in the Nebraska-South Dakota-Wyoming Uranium Milling Region, are
13 similar to the Wyoming East Uranium Milling Region with predominantly private land ownership,
14 but also with land managed by federal and state agencies (e.g., USFS grasslands, Custer State
15 Park, Devil's Tower National Monument). The type and intensity of construction impacts to land
16 use from new ISL facilities in this region would, therefore, be anticipated to be similar to those
17 described for the two Wyoming regions. Construction activities would also: (1) change and
18 disturb the land uses, (2) restrict access and establish right-of-way for access, (3) affect mineral
19 rights, (4) restrict livestock grazing areas, (5) restrict recreational activities, and (6) alter
20 ecological, cultural and historical resources. In this region, the uranium districts are located
21 predominantly on grassland and forest land managed by the USFS, while in the two Wyoming
22 regions land use is predominantly BLM lands. In addition, almost 60 percent of the land in the
23 Nebraska-South Dakota-Wyoming Uranium Milling Region is privately owned. This could lead
24 to potential impacts that would need to be resolved through arrangements (e.g., leases, mineral
25 rights sales, royalties) with individual land owners. Because the amount of area affected by an
26 ISL facility in the Nebraska-South Dakota-Wyoming Uranium Milling Region would be similar to
27 that in the the two Wyoming regions, and only a small portion of that area would be fenced,
28 access would be minimally affected. As a result, potential impacts to most aspects of land use
29 from the construction of an ISL facility would be SMALL. Potential impacts to historic and
30 cultural resources would range from SMALL to LARGE, depending on site-specific conditions,
31 as resources not previously identified could be altered or destroyed during excavation, drilling,
32 and grading activities.

33
34 **4.4.1.2 Operation Impacts to Land Use**

35
36 The types of land use impacts for operational activities would be expected to be similar to
37 construction impacts regarding access restrictions, primarily because the infrastructure would
38 be already in place. Additional land disturbances would not be expected during the operational
39 activities described in detail in Section 2.4. During the operational period of an ISL facility, the
40 primary changes to land use would be the movement (sequencing) of well fields from one are to
41 another, and is addressed as a construction impact in Section 4.4.1.1. Sequentially moving
42 active operations from one well field to the next would shift potential impacts. For example, a
43 well field where uranium recovery activities have ceased could be restored and reopened for
44 grazing or recreation while a new well field is being developed, which would have impacts
45 similar to those described in the preceding section for the construction phase. Because access
46 restriction and land disturbance impacts would be expected to be similar to, or less than, that
47 expected for construction, the overall potential impacts to land use from operational activities
48 would be SMALL.

1 **4.4.1.3 Aquifer Restoration Impacts to Land Use**
2

3 During aquifer restoration, the land use impacts described above for the construction phase and
4 the operations phase would be similar. In terms of specific activities, the aquifer restoration
5 uses the same infrastructure as the operations phase and maintenance would be at a similar
6 level. Land use impacts from aquifer restoration would decrease as fewer wells and pump
7 houses are used and overall equipment traffic and use diminish. Thus, the overall potential
8 impacts to land use during the aquifer restoration phase are comparable to those of the
9 operation phase, and would be SMALL.

10
11 **4.4.1.4 Decommissioning Impacts to Land Use**
12

13 The types of decommissioning impacts to land use in the Nebraska-South Dakota-Wyoming
14 Uranium Milling Region would be similar to the construction, operations and aquifer restoration
15 impacts. As previously described, the level of decommissioning activities disturbing the land
16 uses would increase during this phase because greater use of earth and material moving
17 equipment and other heavy equipment would occur. As decommissioning and reclamation
18 proceed, the amount of disturbed land would decrease. Consequently, the overall potential
19 decommissioning impacts to land use in the Nebraska-South Dakota-Wyoming Uranium Milling
20 Region, would be range from SMALL to MODERATE.

21
22 **4.4.2 Transportation Impacts**
23

24 Truck and automobile use is associated with all phases of the ISL facility lifecycle including
25 construction, operation, aquifer restoration, and decommissioning. The estimated low
26 magnitude of road transportation from all phases of the ISL lifecycle (Section 2.8), when
27 compared with local traffic volumes in the Nebraska-South Dakota-Wyoming Uranium Milling
28 Region (Section 3.4.2) is not expected to significantly affect the amount of traffic or accident
29 rates. One possible exception to this conclusion, is that commuting traffic for facility workers, in
30 particular, during periods of peak employment (during construction), would have greater impacts
31 when traveling roads with the lowest levels of current traffic. This impact would be more
32 pronounced in the Nebraska-South Dakota-Wyoming Uranium Milling Region owing to the
33 relatively lower traffic counts in this region. These low-trafficked roads may also be more
34 susceptible to wear and tear from increased traffic. Localized, short-term and intermittent
35 SMALL to MODERATE impacts associated with noise, dust, and incidental livestock or wildlife
36 kills are possible, depending on the proximity of residences, other regularly occupied structures,
37 or grazing areas to ISL facility access roads. A more detailed assessment of transportation
38 impacts for each phase of the ISL facility lifecycle follows.

39
40 **4.4.2.1 Construction Impacts to Transportation**
41

42 ISL facilities, in general, are not large-scale or time-consuming construction projects
43 (Section 2.3 and Table 2.7-1). The magnitude of estimated construction-related transportation
44 (Section 2.8) is expected to vary depending on the size of the facility. However, when
45 compared to the regional traffic counts provided in Section 3.4.2, most roads that would be used
46 for construction transportation in the Nebraska-South Dakota-Wyoming Uranium Milling Region
47 would not cause significant increases in daily traffic, and therefore, traffic-related impacts would
48 be SMALL. The roads with the lowest average annual daily traffic counts would have higher
49 (MODERATE) traffic and potential infrastructure impacts, in particular, when facilities are

1 experiencing peak (construction) employment. The limited duration of ISL construction activities
2 (12-18 months) suggests impacts would be of short duration. Temporary SMALL to
3 MODERATE dust, noise, and incidental livestock or wildlife impacts are possible on, or in the
4 vicinity of, access roads used for construction transportation.

5 6 **4.4.2.2 Operations Impacts to Transportation**

7
8 The discussion of impacts in Section 4.2.2.2 for the Wyoming West Uranium Milling Region also
9 applies to the Nebraska-South Dakota-Wyoming Uranium Milling Region because the same
10 types of transportation activities would be conducted regardless of location, the same regulatory
11 controls and safety practices apply, the same magnitude of transportation activities would be
12 conducted, and the assessment of accident risks is generally applicable to all regions.
13 Applicable transportation conditions for the Nebraska-South Dakota-Wyoming Uranium Milling
14 Region are discussed in Section 3.4.2. With the magnitude of existing traffic conditions in the
15 region somewhat less than in the other milling regions, the intensity of traffic-related impacts
16 would be similar, and range from SMALL to MODERATE considering potential peak
17 employment commuting impacts to low traffic roads. The methods and assumptions considered
18 in the accident analysis in Section 4.2.2.2 (Wyoming West Uranium Milling Region) for
19 yellowcake shipments are applicable to the Nebraska-South Dakota-Wyoming Uranium Milling
20 Region and therefore, the impact from yellowcake, resin transfer, and byproduct waste
21 shipments would be similar (SMALL). The same practices and requirements that serve to limit
22 the risks from chemical shipments also apply to the Nebraska-South Dakota-Wyoming Uranium
23 Milling Region, and would also result in SMALL impacts.

24 25 **4.4.2.3 Aquifer Restoration Impacts to Transportation**

26
27 Aquifer restoration transportation impacts are expected to be less than described for
28 construction and operations because transportation activities will be primarily limited to supplies
29 (including chemicals), chemical waste shipments, on site transportation, and employee
30 commuting. No additional unique transportation activities are expected during aquifer
31 restoration, therefore, no additional types of impacts associated with aquifer restoration are
32 anticipated, and impacts would be SMALL to MODERATE.

33 34 **4.4.2.4 Decommissioning Impacts to Transportation**

35
36 Decommissioning 11e.(2) by-product wastes (as defined in the Atomic Energy Act) would be
37 shipped offsite by truck for disposal at a licensed disposal site. Section 2.8 provides estimates
38 of the number of decommissioning-related waste shipments, which are small compared to
39 average annual daily traffic counts provided in Section 3.4.2. All radioactive waste shipments
40 must be shipped in accordance with the applicable NRC safety requirements in 10 CFR Part 71.
41 As shown in Section 2.8, the number of estimated decommissioning waste shipments is fewer
42 than those needed to support facility operations and therefore potential traffic and accident
43 impacts are expected to decrease during the decommissioning period. Risks from transporting
44 yellowcake shipments during operations bound the risks expected from waste shipments owing
45 to the concentrated nature of shipped yellowcake, the longer distance yellowcake is shipped
46 relative to waste destined for a licensed disposal facility, and the relative number of shipments
47 for each type of material. Commuting impacts would decrease from peak employment due to
48 cessation of operations, though, this effect would be offset to some degree by an increase in

1 decommissioning workers. Overall, based on the magnitude of transportation activities
2 expected during decommissioning, impacts would be SMALL.
3

4 **4.4.3 Geology and Soils Impacts**

5
6 Construction, operation, aquifer restoration, and decommissioning activities and processes
7 at ISL facilities may impact geology and soils. The potential impacts to geology and soils
8 from these activities in the Nebraska-South Dakota-Wyoming Milling Region are discussed in
9 the following sections.

10 **4.4.3.1 Construction Impacts to Geology and Soils**

11
12 During construction of ISL facilities, the principal impacts on geology and soils would result from
13 earth-moving activities associated with constructing surface facilities, wastewater evaporation
14 ponds, access roads, well fields, and pipelines (Section 2.3). Earth-moving activities
15 would include:
16

- 17
- 18 • Clearing of ground or top soil and preparing surfaces for the processing plant, satellite
19 facilities, pump houses, access roads, drilling sites, and associated structures
- 20
- 21 • Excavating and backfilling trenches for pipelines and cables
- 22
- 23 • Excavating evaporation ponds and developing evaporation pond embankments
- 24

25 The impact of construction activities on geology and soils will depend on local topography,
26 surface bedrock geology, and soil characteristics. Generally, earth-moving activities would
27 result in only SMALL (approximately 10 percent of entire site) and temporary (several months)
28 disturbance of soils—impacts that are commonly mitigated using accepted best management
29 practices (see Section 7). For example, soil horizons will be disrupted to construct the
30 processing facilities, evaporation ponds, and well field houses. In the well field, soil disturbance
31 would be limited to drill pad grading, mud pit excavation, well completion, and access road
32 construction.
33

34 Construction activities at ISL facilities in the Nebraska-South Dakota-Wyoming Milling Region
35 may increase the potential for erosion from both wind and water due to the removal of
36 vegetation and the physical disturbance from vehicle and heavy equipment traffic. Operators of
37 ISL facilities typically adopt construction practices that prevent or substantially reduce erosion.
38 For example, soils removed during construction of surface facilities are generally stockpiled and
39 stabilized for later use during decommissioning and land reclamation. These stockpiles are
40 typically located, shaped, and seeded with a cover crop by the operator to control erosion.
41

42 As part of the underground infrastructure at ISL facilities, a network of buried process pipelines
43 and cables is typically constructed. Pipeline systems are installed between the pump house
44 and well field for injecting and recovering lixiviant, between the pump house and the satellite
45 facility or processing plant for transporting lixiviant and resin, and between the processing
46 facilities and deep injection wells. Trenches for the pipelines are excavated as deep as 6 feet
47 below the ground to avoid any potential freezing problem. Excavating trenches for pipelines
48 and cables normally results in only SMALL, short-term disturbance of rock and soil. After piping

1 and cable are placed in the trenches they are typically backfilled with the excavated material
2 and graded to surrounding ground topography.

3
4 Based on the above discussion, the impacts of construction activities on geology and soils at
5 ISL facilities in the Nebraska-South Dakota-Wyoming Milling Region would be SMALL because
6 of the limited time of the activity (months), the limited affected area (less than 10 percent of
7 site), and the shallow depth of excavation (4-6 feet).

8 9 **4.4.3.2 Operation Impacts to Geology and Soils**

10
11 During ISL operations (Section 2.4), a non-uranium-bearing (barren) solution or lixiviant is
12 injected through wells into the mineralized zone. The lixiviant moves through the pores in the
13 host rock, dissolving uranium and other metals. Production wells withdraw the resulting
14 "pregnant" lixiviant, which contains uranium and other dissolved metals, and pump it to a central
15 processing plant or to a satellite processing facility for further uranium recovery and purification.

16
17 The removal of uranium from the target sandstones during ISL operations would result in a
18 permanent change to the composition of uranium-bearing rock formations. However, the
19 uranium mobilization and recovery process in the target sandstones does not result in the
20 removal of rock matrix or structure and, therefore, no significant matrix compression or ground
21 subsidence is expected. In addition, the source formations for uranium in the Nebraska-South
22 Dakota-Wyoming Milling Region occur at depths of hundreds of feet (Section 3.4.3) and,
23 therefore, impacts to geology from ground subsidence would be SMALL.

24
25 The pressure of the producing aquifer is decreased during operation activities because a
26 negative water balance is maintained in the well field to ensure water flows into the well field
27 from its edges, reducing the spread of contamination. This change in pressure theoretically
28 could impact the transmissivity of faults in permitted areas. However, this change in pressure is
29 not expected to be significant enough to reactivate local faults and it is expected to be extremely
30 unlikely that any earthquakes would be generated. Based on historical ISL operations in the
31 Nebraska-South Dakota-Wyoming Milling Region, reactivation of faults has not been observed.

32
33 A potential impact to soils arises from the need to move barren and pregnant uranium-bearing
34 lixiviant to and from the processing facility in aboveground and underground pipelines. If a pipe
35 ruptures or fails, lixiviant can be released and (1) pond on the surface, (2) run off into surface
36 water bodies, (3) infiltrate and adsorb in overlying soil and rock, or (4) infiltrate and percolate to
37 groundwater. For example, during 1996, the operator of the Crow Butte Uranium Project in
38 Dawes County, Nebraska logged 27 spill incidents, which ranged in volume from 45 to 65,000 L
39 [12 to 17,305 gal] (NRC, 1998).

40
41 In the case of spills from pipeline leaks and ruptures, spills could release either radionuclides or
42 other constituents (e.g., Se or other metals). Any impacts of these two types of spills are likely
43 to be bounded by a spill of pregnant lixiviant (Mackin, et al., 2001). Licensees are expected to
44 establish immediate spill responses through onsite standard operation procedures (e.g., NRC,
45 2003, Section 5.7). For example, immediate spill responses might include shutting down the
46 affected pipeline, recovering as much of the spilled fluid as possible, and collecting samples of
47 the affected soil for comparison to background values for uranium, radium, and other metals.

48
49 As part of the monitoring requirements at ISL facilities, licensees must report certain spills to the
50 NRC within 24 hours. These spills include those that cause unplanned contamination that

1 meets the criteria of 10 CFR 40.60 and those spills that could cause exposures that exceed the
2 dose limits established in 10 CFR 20 Subpart M. Additional reporting requirements may be
3 imposed by the state or by NRC license conditions. For example, NRC license conditions may
4 require that licensees report spills to the NRC project manager and subsequently submit a
5 written report describing the conditions leading to the spill, the corrective actions taken, and the
6 results achieved (NRC, 2003). This documentation helps in final site decommissioning
7 activities. Licensees of ISL facilities in the Nebraska-South Dakota-Wyoming Milling Region
8 must also comply with any applicable state permitting agency requirements for spill response
9 and reporting.

10
11 Soil contamination during ISL operations could also occur from transportation accidents
12 resulting in yellowcake or ion exchange resin spills. As for lixiviant spills, licensees must report
13 certain of these yellowcake or resin spills to both the NRC and the appropriate state permitting
14 agency. License conditions also may require licensees to report the corrective actions taken
15 and the results achieved. For non-radiological chemicals stored at the processing facility, spill
16 responses would be similar to those described for yellowcake transportation, although the spill
17 of non-radiological materials is primarily reportable to the appropriate state agency or EPA. At
18 the Crow Butte Uranium Project in Nebraska, concrete berms that can retain the volume of the
19 tank are used to contain spills from process chemical storage tanks and simplify cleanup (NRC,
20 1998).

21
22 Uranium mobilization and processing during ISL operations produces excess water containing
23 lixiviants and minerals leached from the aquifer. Other liquid waste streams produced by ISL
24 operations can include rejected brine from the reverse osmosis system and spent eluant from
25 the ion exchange system. Any of these waste streams may be discharged to evaporation ponds
26 or injected into deep waste disposal wells. In addition, wastewater may be treated and applied
27 to the land using irrigation methods or discharged to surface water drainages. The impacts and
28 requirements for discharging treated waste streams to surface water bodies during ISL activities
29 in the Nebraska-South Dakota-Wyoming Milling Region are discussed in Section 4.4.4.1. The
30 impacts of using evaporation ponds or applying treated wastewater to the land are discussed in
31 this section.

32
33 Although waste streams are treated before discharge to evaporation ponds, they may still
34 contain radionuclides and other metals that may become concentrated during evaporation.
35 Therefore, soil contamination could result if either the liner or embankment of an evaporation
36 pond was to fail. Evaporation ponds at NRC-licensed ISL facilities are designed with leak
37 detection systems to detect liner failures. For example, several minor leaks were identified
38 through the monitoring of the leak detection system at the Crow Butte Uranium Project, and
39 repairs were made before contamination became an issue (NRC, 1998). The licensee is also
40 required to maintain sufficient reserve capacity in the evaporation pond system to enable
41 transferring the contents of a pond to other ponds in the event of a leak and subsequent
42 corrective action and liner repair. To minimize the likelihood of failure, pond embankments at
43 ISL facilities are monitored and inspected by licensees in accordance with NRC-approved
44 inspection programs, and NRC currently inspects the embankments regularly as part of the
45 federal Dam Safety program.

46
47 Land application of treated wastewater involves irrigating select parcels of land and allowing the
48 water to be transpired by native vegetation or crops (Sections 2.7.2, 4.2.12.2). Land application
49 of treated wastewater could potentially impact soils. For example, the salinity of the treated
50 waste water could increase the salinity of soils (soil salination) and reduce the permeability of

1 soils in the irrigation area. Land application of the treated wastewater could also cause
2 radiological and/or other constituents (e.g., selenium and other metals) to accumulate in the
3 soils. At NRC-licensed ISL facilities, the licensee is required to monitor and control irrigation
4 areas, if used, to maintain levels of radioactive constituents within allowable release standards.
5 In addition, states, which typically regulate land application of wastewater, may impose release
6 limits on non-radiological constituents. The licensee uses its environmental monitoring program
7 (see Chapter 8) to identify soil impacts caused by land application of treated process water. For
8 example, efforts to identify impacts to soil resulting from land application at the Crow Butte
9 Uranium Project include: (1) water analysis prior to release for land application to assure
10 compliance with release limits, (2) soil sampling to establish background for uranium, radium,
11 and other metals, (3) soil sampling for Ra-226 after each irrigation season, (4) groundwater
12 sampling from monitoring wells near irrigation areas, and (5) surface water sampling from
13 impoundments and streams near irrigation areas (NRC, 1998). Areas of a site where land
14 application of treated water has been used are also included in decommissioning surveys to
15 ensure soil concentration limits are not exceeded. Because of the routine monitoring program
16 and inclusion of land application areas in decommissioning surveys, the impacts to soil from
17 land application of treated wastewater would be expected to be SMALL.

18 19 **4.4.3.3 Aquifer Restoration Impacts to Geology and Soils**

20
21 Aquifer restoration programs typically use a combination of (1) groundwater transfer,
22 (2) groundwater sweep, (3) reverse osmosis, permeate injection, and recirculation,
23 (4) stabilization, and (5) water treatment and surface conveyance (Section 2.5).

24
25 The groundwater sweep and recirculation process does not result in the removal of rock matrix
26 or structure and, therefore, no significant matrix compression or ground subsidence is expected.
27 The water pressure in the aquifer is decreased during restoration because a negative water
28 balance is maintained in the well field being restored to ensure water flows into the well field
29 from its edges, reducing the spread of contamination. However, the change in pressure is
30 limited by re-injection and recirculation of treated groundwater and, therefore, it is very unlikely
31 that ISL operations will reactivate local faults and extremely unlikely that any earthquakes would
32 be generated. Therefore, the impacts to geology in the Nebraska-South Dakota-Wyoming
33 Milling Region from aquifer restoration are expected to be SMALL, if any.

34
35 The main impact on soils during aquifer restoration would be spills of contaminated groundwater
36 resulting from pipeline leaks and ruptures. As with spills of lixiviant during operations, spill
37 response recommendations during aquifer restoration activities have been carried forward into
38 NRC guidance of ISL facilities (e.g., NRC, 2003, Section 5.7). Licensees must report certain
39 spills to the NRC within 24 hours. These spills include those that cause unplanned
40 contamination that meets the criteria of 10 CFR 40.60 and those spills that could cause
41 exposures that exceed the does limits established in 10 CFR 20 Subpart M. Additional
42 reporting requirements may be imposed by the state or by NRC license conditions. For
43 example, NRC license conditions may require that licensees report spills to the NRC project
44 manager and subsequently submit a written report describing the conditions leading to the spill,
45 the corrective actions taken, and the results achieved (NRC, 2003). Licensees in the
46 Nebraska-South Dakota-Wyoming Milling Region are also required to comply with spill response
47 and reporting requirements of the appropriate state permitting agency. The short-term impact
48 on soils from spills of contaminated groundwater could range from SMALL to LARGE depending
49 on the volume of affected soil. Because of the required immediate responses, spill recovery

1 actions, and routine monitoring programs, impacts from spills are temporary, and the overall
2 long-term impact to soils is SMALL.
3

4 During aquifer restoration the groundwater is passed through semipermeable membranes that
5 yields a brine or reject liquid. This reject liquid cannot be injected back into the aquifer or
6 discharged directly to the environment. The reject liquid is typically sent to an evaporation pond
7 or to deep well disposal. In addition, treated wastewater may be applied to the land.
8

9 If reject water is sent to an evaporation pond, failure of the evaporation pond liner or pond
10 embankment could result in soil contamination. Evaporation ponds at NRC licensed ISL
11 facilities are designed with leak detection systems to detect liner failures and are visually
12 inspected on a regular basis. The licensee is also required to maintain sufficient reserve
13 capacity in the evaporation pond system to enable transferring the contents of a pond to other
14 ponds in the event of a leak and subsequent corrective action and liner repair. To minimize the
15 likelihood of pond embankment failures, NRC requires licensees to monitor and inspect pond
16 embankments at ISL facilities in accordance with NRC-approved inspection programs. NRC
17 currently inspects the embankments regularly as part of the federal Dam Safety program.
18

19 As with ISL operations, land application of treated waste water during aquifer restoration could
20 potentially impact soils (Sections 2.7.2, 4.2.12.2). For example, the salinity of the treated waste
21 water could increase the salinity of soils (soil salination) and reduce the permeability of soils in
22 the irrigation area. Land application of the treated wastewater could also cause radiological
23 and/or other constituents to accumulate in the soils. At NRC-licensed ISL facilities, the licensee
24 is required to monitor and control irrigation areas, if used, to maintain levels of radioactive
25 constituents within allowable release standards. In addition, states, which typically regulate land
26 application of wastewater, may impose release limits on non-radiological constituents. The
27 licensee uses its environmental monitoring program (see Chapter 8) to identify soil impacts
28 caused by land application of treated process water. Monitoring includes analyzing water
29 before it is applied to land to make sure release limits are met and soil sampling to ensure that
30 concentrations of uranium, radium, and other metals are within allowable standards. Areas of a
31 site where land application of treated water has been used are also included in
32 decommissioning surveys to ensure soil concentration limits are not exceeded. Because of the
33 routine monitoring program and inclusion of land application areas in decommissioning surveys,
34 the impacts to soil from land application of treated wastewater would be SMALL.
35

36 **4.4.3.4 Decommissioning Impacts to Geology and Soils**

37
38 Decommissioning of ISL facilities includes: (1) dismantling process facilities and associated
39 structures, (2) removing buried piping, and (3) plugging and abandoning wells using accepted
40 practices. The main impacts to geology and soils in the Nebraska-South Dakota-Wyoming
41 Milling Region during decommissioning would be from activities associated with land
42 reclamation and cleanup of contaminated soils. These activities are described in Section 2.6.
43

44 Before decommissioning and reclamation activities begin, the licensee is required to submit a
45 decommissioning plan to NRC for review and approval. The licensee's spill documentation, an
46 NRC requirement, would be used to identify potentially contaminated soils requiring offsite
47 disposal at a licensed facility. Any areas potentially impacted by operations would be included
48 in surveys to ensure all areas of elevated soil concentrations are identified and properly
49 cleaned up to comply with NRC regulations at 10 CFR Part 40, Appendix A, Criterion 6-(6).
50

1 Most of the impacts to geology and soils associated with decommissioning are temporary and
2 SMALL. Because the goal of decommissioning and reclamation is to restore the facility to
3 preproduction conditions to the extent practical, the overall long-term impacts to the geology
4 and soils would be SMALL.
5

6 **4.4.4 Water Resources Impacts**

7 **4.4.4.1 Surface Water Impacts**

8 **4.4.4.1.1 Construction Impacts to Surface Water**

9
10
11
12 The potential causes and nature of impacts for the Nebraska-South Dakota-Wyoming
13 Uranium Milling Region are expected to be similar to impacts discussed for the Wyoming
14 West Uranium Milling Region (Section 4.2.4.2.1). Because the average annual runoff in the
15 Nebraska-South Dakota-Wyoming Uranium Milling Region is more than in most portions of the
16 Wyoming West Uranium Milling Region, the potential for surface water impacts is slightly
17 greater in the Nebraska-South Dakota-Wyoming Uranium Milling Region (U.S. Geological
18 Survey, 2008). Storm water runoff water quality is regulated by permits issued by Nebraska,
19 South Dakota, and Wyoming (Section 1.7.5.2). Potential impacts to wetlands would be
20 addressed through the appropriate consultations and permitting processes (e.g. USACE, state).
21 As noted in Section 4.2.4.1.1, Wyoming has jurisdiction over isolated wetlands. While no
22 state-administered permitting process is in place for wetlands in Nebraska, they are
23 protected under Title 117 of the Nebraska Surface Water Quality Standards. Compliance
24 with applicable federal and state regulations and permit conditions and use of best management
25 practices and required mitigation measures would reduce impacts to SMALL to MODERATE,
26 depending on site-specific conditions.
27

28 **4.4.4.1.2 Operational Impacts to Surface Water**

29
30 Because precipitation and the number of perennial streams is similar (Section 3.4.4.1), the
31 potential causes and nature of impacts to surface water resources in the Nebraska-South
32 Dakota-Wyoming Uranium Milling Region would be expected to be similar to impacts discussed
33 for the Wyoming West Uranium Milling Region (Section 4.2.4.2.2). Storm water runoff water
34 quality and other discharges to surface water are regulated by state pollutant discharge
35 elimination system permits issued by Nebraska, South Dakota, and Wyoming (Section 1.7.2.1).
36 Compliance with permit conditions and use of best management practices and required
37 mitigation measures would reduce operations impacts to surface water to SMALL to
38 MODERATE, depending on local conditions.
39

40 **4.4.4.1.3 Aquifer Restoration Impacts to Surface Water**

41
42 Because precipitation and the number of perennial streams is similar (Section 3.4.4.1), the
43 potential causes and nature of impacts for the Nebraska-South Dakota-Wyoming Uranium
44 Milling Region are expected to be similar to impacts discussed for Wyoming West Uranium
45 Milling Region (Section 4.2.4.2.3). Storm water runoff water quality and other discharges to
46 surface water are regulated by state pollutant discharge elimination system permits issued by
47 Nebraska, South Dakota, and Wyoming (Section 1.7.2.1). Compliance with permit conditions
48 and use of best management practices and required mitigation measures would reduce impacts

1 from aquifer restoration to surface water to SMALL to MODERATE, depending on local
2 conditions.

3
4 **4.4.4.1.4 Decommissioning Impacts to Surface Water**

5
6 Because precipitation and the number of perennial streams is similar (Section 3.4.4.1), the
7 potential causes and nature of impacts for the Nebraska-South Dakota-Wyoming Uranium
8 Milling Region are expected to be similar to impacts discussed for Wyoming West Uranium
9 Milling Region (Section 4.2.4.2.4). Storm water runoff water quality is regulated by state
10 pollutant discharge elimination system permits issued by Nebraska, South Dakota, and
11 Wyoming (Section 1.7.2.1). Compliance with permit conditions and use of best management
12 practices and required mitigation measures would reduce decommissioning impacts to surface
13 water to SMALL to MODERATE, depending on local conditions.

14
15 **4.4.4.2 Groundwater Impacts**

16
17 Potential environmental impacts to groundwater resources in the Nebraska-South Dakota-
18 Wyoming Uranium Milling Region can occur during all phases of the ISL facility's lifecycle. ISL
19 activities can impact aquifers at varying depths (separated by aquitards) above and below the
20 uranium-bearing aquifer as well as adjacent surrounding aquifers in the vicinity of the uranium-
21 bearing aquifer. Surface activities that can introduce contaminants into soils are more likely to
22 impact shallow (near-surface) aquifers while ISL operations and aquifer restoration are more
23 likely to impact the deeper uranium-bearing aquifer, any aquifers above and below, and
24 adjacent surrounding aquifers.

25
26 ISL facility impacts to groundwater resources can occur from surface spills and leaks,
27 consumptive water use, horizontal and vertical excursions of leaching solutions from production
28 aquifers, degradation of water quality from changes in the production aquifer's geochemistry,
29 and waste management practices involving land application of treated wastewater, evaporation
30 ponds, or deep well injection. Detailed discussion of the potential impacts to groundwater
31 resources from construction, operations, aquifer restoration, and decommissioning are provided
32 in the following sections.

33
34 **4.4.4.2.1 Construction Impacts to Groundwater**

35
36 During construction of ISL facilities, the potential for groundwater impacts is primarily from
37 consumptive groundwater use, drilling fluids and muds from well drilling, and spills of fuels and
38 lubricants from construction equipment (Section 2.3).

39
40 As discussed in Section 2.11.3, groundwater use during construction is limited to routine
41 activities such as dust suppression, mixing cements, and drilling support. The amounts of
42 groundwater used in these activities are small and would have a SMALL and temporary impact
43 to groundwater supplies. Groundwater quality of near surface aquifers during construction is
44 protected by best management practices such as implementation of a spill prevention and
45 cleanup plan to minimize soil contamination (Section 7.4). Additionally, the amount of drilling
46 fluids and muds introduced into aquifers during well construction would be limited and have a
47 SMALL impact to the water quality of those aquifers. Thus, construction impacts to groundwater
48 resources would be SMALL based on the limited nature of construction activities and
49 implementation of management practices to protect shallow groundwater.

1 4.4.4.2.2 Operation Impacts to Groundwater
2

3 During ISL operations, potential environmental impacts to shallow (near-surface) aquifers are
4 related to leaks of lixiviant from pipelines, wells, or header houses and to waste management
5 practices such as the use of evaporation ponds and disposal of treated wastewater by land
6 application. Potential environmental impacts to groundwater resources in the production and
7 surrounding aquifers involve consumptive water use and changes to water quality. Water
8 quality changes would result from normal operations in the production aquifer and from possible
9 horizontal and vertical lixiviant excursions beyond the production zone (Section 2.4). Disposal
10 of processing wastes by deep well injection (Section 2.7.2) during ISL operations also can
11 potentially impact groundwater resources.

12
13 4.4.4.2.2.1 Operation Impacts to Shallow (Near-Surface) Aquifers
14

15 A network of pipelines, as part of the underground infrastructure, is used during ISL operations
16 for transporting lixivants between the pump house and the satellite or main processing facility
17 and also to connect injection and extraction wells to manifolds inside pumping header houses.
18 The failure of pipeline fittings or valves, or failures of well mechanical integrity in shallow
19 aquifers, could result in leaks and spills of pregnant and barren lixiviant (Section 2.3.1.2), which
20 could impact water quality in shallow (near-surface) aquifers. The potential environmental
21 impacts of pipeline, valve, or well integrity failures could be MODERATE to LARGE, if
22

- 23 • the ground water table in shallow aquifers is close to the ground surface (i.e., small
24 travel distances from the ground surface to the shallow aquifers)
- 25
- 26 • the shallow aquifers are important sources for local domestic or agricultural
27 water supplies
- 28
- 29 • shallow aquifers are hydraulically connected to other locally or regionally important
30 aquifers.
- 31

32 The potential environmental impacts could be SMALL, if shallow aquifers have poor water
33 quality or yields not economically suitable for production and if they are hydrologically separated
34 from other locally and regionally important aquifers.
35

36 In the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling region,
37 local shallow alluvium aquifers exist. They are not important aquifers for water supplies in most
38 areas, but are used for local supplies in some areas (Section 3.4.4.3.1). Hence, potential
39 environmental impacts due to spills and leaks from pipeline networks or well integrity failures in
40 shallow aquifers could be SMALL to MODERATE, depending on site-specific conditions.
41 Potential impacts would be reduced by flow monitoring to detect pipeline leaks and spills early
42 and implementation of required spill response and cleanup procedures. In addition,
43 preventative measures such as well mechanical integrity testing (Section 2.3.1.1) would limit the
44 likelihood of well integrity failure during operations.
45

46 The use of evaporation ponds or land application to manage process water generated during
47 operations also could impact shallow aquifers. For example, failure of evaporation pond
48 embankments or liners could allow contaminants to infiltrate into shallow aquifers. Similarly,
49 land application of treated wastewater could cause radiological or other constituents (e.g., Se or

1 other metals) to accumulate in soils or infiltrate into shallow aquifers. In general, the potential
2 impacts of these waste management activities are expected to be limited by NRC and state
3 requirements. For example, NRC requirements for leak detection systems, maintenance of
4 reserve pond capacity, and pond embankment inspections are expected to minimize the
5 likelihood of evaporation pond failures. Similarly, NRC and state release limits related to land
6 application of waste are expected to limit potential effects of land application of waste water on
7 shallow aquifers. Section 4.2.12.2 discusses the impacts of the use of evaporation ponds and
8 land application of treated wastewater in greater detail and characterizes the expected impacts
9 as SMALL.

10 4.4.4.2.2.2 Operation Impacts to Production and Surrounding Aquifers

11 The potential environmental impacts to groundwater supplies in the production and other
12 surrounding aquifers are related to consumptive water use and groundwater quality.

13 **Water Consumptive Use :** NRC-licensed flow rates for ISL facilities typically range from about
14 15,100 to 34,000 L/min [4,000 to 9,000 gal/min] (Section 2.1.3). Most of this water is returned to
15 the production aquifer after being stripped of uranium (see Section 2.4.1.2). The term
16 “consumptive use” refers to water that is not returned to the production aquifer. During
17 operations, consumptive use is due primarily to production bleed (typically between 1 and 3
18 percent of the total flow) and also includes other smaller losses. As described in Section
19 2.4.1.2, the purpose of the production bleed is to ensure that more groundwater is extracted
20 than re-injected. Maintaining this negative water balance helps to ensure that there is a net
21 inflow of groundwater into the well field to minimize the potential movement of lixiviant and its
22 associated contaminants out of the well field. Because the bleed water must be removed from
23 the well field to maintain a negative water balance, the bleed is disposed through the waste
24 water control program and is not re-injected into the well field.

25 Hypothetically, if a well field at an ISL facility in the Nebraska-South Dakota-Wyoming Uranium
26 Milling Region is pumped at a constant rate of 22,700 L/min [6,000 gal/min] with 2 percent
27 bleed, the total volume of production bleed in a year of operation would be 240 million L [63
28 million gal {190 acre-ft}]. For comparison, in 2000, approximately 5.16×10^{11} L [418,000 acre-ft]
29 of water was used to irrigate 143,000 ha [354,000 acres] of land in South Dakota (Hutson *et al.*,
30 2004). This irrigation rate is equivalent to an annual application of approximately 3.60 million L
31 per hectare [1.18 acre-ft/acre]. Similarly, the average irrigation rate (for irrigated land) in
32 Nebraska is 3.84 million L per hectare [1.26 acre-ft/acre] (Hutson *et al.*, 2004). Thus, the
33 consumptive use of 240 million L [190 acre-ft] of water due to production bleed in one year of
34 operation is roughly equivalent to the water used to irrigate 67 ha [166 acres] in South Dakota or
35 63 ha [156 acres] in Nebraska for one year.

36 Consumptive water use during operations could impact local water users who use water from
37 the production aquifer (outside of the exempted zone) by lowering water levels in local wells. In
38 addition, if production aquifers are not completely hydraulically isolated from aquifers above and
39 below, consumptive use may impact local users of these connected aquifers by causing a
40 lowering of water levels in those aquifers. However, effects on aquifers above and below are
41 expected to be limited in most cases by the confining layers typical of aquifers used for ISL
42 production. As discussed in Section 2.4.1.3, licensees conduct pre-operations testing to assess
43 the degree of hydraulic isolation of potential production aquifers at proposed ISL sites.

1 To assess the potential drawdown that could be caused by consumptive use during operations,
2 drawdowns were calculated for a hypothetical case in which the water withdrawn by an entire
3 ISL facility operating at 15,100 L/min [4,000 gal/min] with 2 percent bleed is assumed to be
4 withdrawn from a single well. This scenario would significantly overestimate the drawdown
5 caused by ISL operations using water from a similar production aquifer because water
6 withdrawal at a typical ISL facility is distributed among hundreds of wells (Section 2.3.1.1) and
7 tens to hundreds of hectares [tens to thousands of acres] (Section 4.2.1). Drawdowns for this
8 hypothetical case were calculated using the Theis Equation (McWhorter and Sunada, 1977)
9 with representative values of the transmissivity and storage coefficient for the South Dakota and
10 Nebraska sections of the Nebraska-South Dakota-Wyoming Uranium Milling Region. As
11 discussed in Section 4.3.4.2.2.2, drawdowns are found to be more sensitive to the aquifer
12 transmissivity than storage coefficient.

13
14 In the South Dakota section of the milling region, representative values of the transmissivity and
15 storage coefficient of the Inyan Kara ore-bearing aquifer are 300 m²/day [3,229 ft²/day] and 5 ×
16 10⁻⁴, respectively (chosen from the range of respective parameter values discussed in Section
17 3.4.4.3). In this case, drawdowns resulting from bleed production at a constant rate over 10
18 years of ISL operations are 2.6 m [8.5 ft], 2.0 m [6.6 ft], and 1.5 m [4.9 ft] at locations 1 m [3.3
19 ft], 10 m [33 ft], and 100 m [330 ft] away from a hypothetical pumping well representing the
20 withdrawals from an entire ISL facility.

21
22 In the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region,
23 representative values of the transmissivity and storage coefficient of the ore-bearing aquifer are
24 38 m²/day (409 ft²/day) and 5 × 10⁻⁴, respectively (chosen from the range of respective
25 parameter values discussed in Section 3.4.4.3). In this case, drawdowns resulting from bleed
26 production (pumped water volume not returned to the ore-bearing aquifer) at a constant rate
27 over 10 years of ISL operations are 19 m [61 ft], 14 m [47 ft], and 10 m [33 ft] at locations 1 m
28 [3.3 ft], 10 m [33 ft], and 100 m [330 ft] away from a hypothetical pumping well representing the
29 withdrawals from an entire ISL facility.

30
31 In the calculations above, the potential effect of natural recharge to the production aquifers on
32 groundwater levels is not considered. The significance of recharge will depend on the isolation
33 of the producing aquifer and the infiltration into any outcrops. For example, the Chadron
34 Sandstone crops out in northwest Nebraska, where it is likely that recharge occurs (Collings and
35 Knode, 1984). Consideration of natural recharge would reduce the calculated drawdowns.
36 However, neglecting natural recharge is not expected to have as much of an effect as
37 approximating the withdrawal from an entire facility with one hypothetical well. As previously
38 discussed, this approximation is expected to yield significant overestimates of the expected
39 drawdowns.

40
41 Near a well field, the short-term impact of consumptive use in the Nebraska section of the
42 Nebraska-South Dakota-Wyoming Uranium Milling Region aquifer could be MODERATE if there
43 are local water users who use the production aquifer (outside of the exempted zone) or if the
44 production aquifer is not well-isolated from other aquifers that are used locally. In the South
45 Dakota section of the region, short-term impacts are expected to be SMALL to MODERATE,
46 depending on aquifer characteristics (e.g., transmissivity). In both sections of the region, these
47 localized effects are expected to be temporary because drawdown near well fields would
48 dissipate after pumping stops. Thus in both sections of the region, the long-term impacts are
49 expected to be SMALL in most cases, depending on site-specific conditions. Important site-
50 specific conditions include the consumptive use of the proposed facility, the proximity of water

1 users' wells to the well fields, the total volume of water in the production aquifer, the natural
2 recharge rate of the production aquifer, the transmissivity and storage coefficient of the
3 production aquifer, and the degree of isolation of the production aquifer from aquifers above and
4 below.

5
6 **Excursions and Groundwater Quality:** Groundwater quality in the production aquifer is
7 degraded as part of the ISL facility's operations (Section 2.4). The restoration of the production
8 aquifer is discussed in Section 2.5. In order for ISL operations to occur, the uranium-bearing
9 production aquifer would need to be exempted as an underground source of drinking water
10 through the appropriate EPA or state-administered UIC program. When uranium recovery is
11 complete in a well field, the licensee is required to initiate aquifer restoration activities to restore
12 the production aquifer to baseline or pre-operational class-of-use conditions, if possible. If the
13 aquifer cannot be returned to pre-operational conditions, NRC requires that the production
14 aquifer be returned to the maximum contaminant levels provided in Table 5C of 10 CFR 40
15 Appendix A or to and Alternate Concentration Limit (ACL) approved by the NRC. For these
16 reasons, potential impacts to the water quality of the uranium-bearing production zone aquifer
17 as a result of ISL operations would be expected to be SMALL and temporary. The remainder of
18 this section discusses the potential for groundwater quality in the surrounding aquifers or
19 outside of the production zone of the producing aquifer to be impacted by excursions during ISL
20 operation.

21
22 During normal ISL operations, inward hydraulic gradients are expected to be maintained by
23 production bleed so that groundwater flow is towards the production zone from the edges of the
24 well field. If this inward gradient is not maintained, horizontal hydraulic gradients can occur and
25 lead to the spread of leaching solutions in the ore-bearing aquifer beyond the mineralization
26 zone. The rate and extent of spread is largely driven by the collective effects of the aquifer
27 transmissivity, groundwater flow direction, and aquifer heterogeneity. The impact of horizontal
28 excursions could be MODERATE to LARGE if a large volume of contaminated water leaves the
29 production zone and moves downgradient within the production aquifer while the production
30 aquifer outside the mineralization zone is used for water production. To reduce the likelihood
31 and consequences of potential excursions at ISL facilities, NRC requires licensees to take
32 preventative measures prior to starting operations. For example, licensees must install a ring of
33 monitoring wells within and encircling the production zone to permit early detection of horizontal
34 excursions (Chapter 8). If excursions are detected, the monitoring well is placed on excursion
35 status and reported to the NRC. Corrective actions are taken and the well is placed on a more
36 frequent monitoring schedule until the well is found to no longer be in excursion.

37
38 The following discussion focuses on the potential for groundwater quality in the surrounding
39 aquifers to be impacted during ISL operations. The rate of vertical flow and the potential for
40 excursions between the production aquifer and an aquifer above or below is determined by
41 groundwater level (piezometric head) differences between the adjacent aquifers and the
42 thickness and vertical hydraulic conductivity of aquitards that hydraulically separate them
43 (McWhorter and Sunada, 1977; Driscoll, 1986).

44
45 In the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region,
46 for example, for a vertical hydraulic gradient of 0.1 in the upward direction between two aquifers
47 (the overlying Mudstone and underlying Inyan Kara aquifer) and the vertical hydraulic
48 conductivity of 4.0×10^{-7} m/day [1.3×10^{-6} ft/day] for the Skull Creek Shale (Section 3.4.4.3), a
49 leaching solution would move vertically upward from the production aquifer (the Inyan Kara

1 aquifer) to the overlying aquifer (Mudstone) at a rate of nearly 0.001 cm/yr [0.0004 in/yr]. If the
2 vertical migration rate of a leaching solution is assumed be constant in the next 10 years, then
3 the leaching solution would move 0.01 cm [0.004 in] away from the production zone. Because
4 the thickness of Skull Creek Shale (the upper confinement) is 46–82 m [150–270 ft] (Section
5 3.3.4.3), the leaching solution would not be able to enter the overlying aquifer in the course of
6 10 years of ISL operation. If excursions are observed at the monitoring wells, the licensee is
7 required to implement responses that include increasing sampling and commencing corrective
8 actions to recover the excursion. The excursions typically would be reversed by increasing the
9 overproduction rate and drawing the lixiviant back into the extraction zone.

10
11 In the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region, for
12 example, for a vertical hydraulic gradient of 0.1 in the upward direction between two aquifers
13 and a vertical hydraulic conductivity of 5.0×10^{-7} m/day [1.6×10^{-6} ft/day] for an aquitard
14 separating those two aquifers (representing the upper confinement of the Basal Chadron
15 sandstone in Section 3.4.4.3), a leaching solution would move vertically upward from the
16 production aquifer to an overlying aquifer at a rate of nearly 0.002 cm/yr [0.0008 in/yr]. If the
17 vertical migration rate of a leaching solution is assumed be the same in the next 10 years, then
18 the leaching solution would move 0.02 cm [0.008 in] away from the production zone. Because
19 the thickness of upper confinement of the Basal Chadron Sandstone is up to 3–8 m [10–25 ft]
20 (Section 3.3.4.3), the excursion would not be expected to enter the overlying aquifer during 10
21 years of ISL operation. If excursions are observed at the monitoring wells, the licensee is
22 required to implement responses that include increasing sampling and commencing corrective
23 actions to recover the excursion. Excursions typically are reversed by increasing the
24 overproduction rate and drawing the lixiviant back into the extraction zone.

25
26 Vertical hydraulic head gradients between the production aquifer and the underlying and
27 overlying aquifers could be altered by potential increases in pumpage from the overlying or
28 underlying aquifers for water supply purposes in the vicinity of an ISL facility (e.g., from the
29 overlying Newcastle Sandstone or the underlying Morrison Formation in the western South
30 Dakota section of the milling region), which may enhance potential vertical excursions from the
31 production aquifer (sandstone aquifers in the Inyan Kara Group). Discontinuities in the
32 thickness and spatial heterogeneities in the vertical hydraulic conductivity of confining units
33 could lead to vertical flow and excursions.

34
35 In addition, potential well integrity failures during ISL operations could lead to vertical
36 excursions. Well casings above or below the uranium-bearing aquifer—through inadequate
37 construction, degradation, or accidental rupture—could allow lixiviant to travel from the well bore
38 into the surrounding aquifer. Moreover, deep monitoring wells drilled through the production
39 aquifer and confining units that penetrate aquitards could potentially create vertical pathways for
40 excursions of lixiviant from the production aquifers to the adjacent aquifers.

41
42 Some relevant factors when considering the significance of potential impacts from a vertical
43 excursion (such as local geology and hydrology, and the proximity of injection wells to drinking
44 water supply wells) are discussed in Section 2.4.1. Additionally, past experience with
45 excursions reported at NRC-licensed ISL facilities are discussed in Section 2.11.5.

46
47 To reduce the likelihood and consequences of potential excursions at ISL facilities, NRC
48 requires licensees to take preventive measures prior to starting operations. For example,
49 licensees must conduct MIT to ensure that lixiviant would remain in the well and not escape into

1 surrounding aquifers (Section 2.3.1). Licensees are required to conduct aquifer pump tests
2 prior to starting operations in a well field. The purpose of these pump tests is to determine
3 aquifer parameters (e.g., aquifer transmissivity and storage coefficient, and the vertical hydraulic
4 conductivity of aquitards) and also to ensure that confining layers above and below the
5 production zone are expected to preclude the vertical movement of fluid from the production
6 zone into the overlying and underlying units. The licensee must also develop and maintain
7 monitoring programs to detect both vertical and horizontal excursions and must have operating
8 procedures to analyze an excursion and determine how to remediate it. The monitoring
9 programs prescribe the number, depth, and location of monitoring wells, sampling intervals,
10 sampling water quality parameters, and the UCLs for particular water quality parameters
11 (Chapter 8). These specifications typically are made conditions in the NRC license.

12
13 Monitoring wells typically are completed in the lower portion of the first aquifer above the ore-
14 bearing aquifer and in the upper portion of the first aquifer below the ore-bearing aquifer. As
15 discussed in Section 3.3.4.3.2, the Basal Chadron Sandstone is underlain by a thick Pierre
16 Shale Sandstone and it is overlain by the Brule Formation.

17
18 In general, the potential environmental impacts of vertical excursions to groundwater quality in
19 surrounding aquifers would be SMALL, if the vertical hydraulic head gradients between the
20 production aquifer and the adjacent aquifer are small, the vertical hydraulic conductivity of the
21 confining units is low, and the confining layers are sufficiently thick. On the other hand, the
22 environmental impacts could be MODERATE to LARGE, if confinements are discontinuous,
23 thin, or fractured (i.e., if they have high vertical hydraulic conductivities). To limit the likelihood
24 of vertical excursions, licensees must conduct MIT to ensure that lixiviant would remain in the
25 well and not escape into surrounding aquifers (Section 2.3.1). Licensees also must conduct
26 pre-operational pump tests to ensure adequate confinement of the production zone. In addition,
27 licensees must develop and maintain programs to monitor above and below the ore-bearing
28 zone to detect both vertical and horizontal excursions and flow rates, and must have operating
29 procedures to analyze an excursion and determine how to remediate it.

30
31 Briefly, the Inyan Kara aquifer is effectively confined above by the Skull Creek Shale and by the
32 Pierre Shale below. Both confinements have small vertical hydraulic conductivities
33 (Section 3.3.4.3.3), which could preclude downward vertical excursions from the production
34 aquifer. Similarly, at the Crow Butte site in Nebraska, the Basal Chadron Sandstone is confined
35 below by the thick Pierre Shale and above by the clay layers with a thickness up to 3–8 m
36 [10–25 ft]. Both confinements have small vertical hydraulic conductivities (Section 3.3.4.3.3),
37 which could preclude downward vertical excursions from the production aquifer. Preliminary
38 calculations discussed previously suggest that the confinements in both sections of the uranium
39 milling region would effectively restrict potential vertical excursions from the ore-bearing
40 aquifers. Additionally, if the licensee installs and maintains the monitoring well network
41 properly, potential impacts of vertical excursions would be temporary and the long-term effects
42 would be SMALL.

43 44 4.4.4.2.2.3 Operation Impacts to Deep Aquifers Below the Production Aquifers

45
46 Potential environmental impacts to confined deep aquifers below the production aquifers could
47 be due to deep well injection of processing wastes into deep aquifers. Under different
48 environmental laws such as the Clean Water Act and the Safe Drinking Water Act, EPA has
49 statutory authority to regulate activities that may affect the environment. Underground injection

1 of fluid requires a permit from either the U.S. EPA or the authorized state (e.g. Nebraska or
2 Wyoming) (Section 1.7.2).

3
4 In the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling region, all
5 the aquifers between the Inyan Kara Group (ore mineralization zone) and the impermeable base
6 rocks including, from shallowest to deepest, the Minnekahta Limestone, the Minnelusa
7 Formation, the Madison Formation, and the Deadwood Formation are considered to be
8 important aquifers for water supplies and reportedly have been extensively used for water
9 supplies in the region (Williamson and Carter, 2001). Thus, none of the deep aquifers below the
10 Inyan Kara Group appear to be suitable for deep injection in the region.

11
12 In the Nebraska section of the Western Nebraska-South Dakota-Wyoming Uranium Milling
13 region, the Basal Chadron aquifer is underlain by thick Pierre Shale at the Crown Butte Uranium
14 Project area (NRC, 1998). Additional information would be needed to determine whether a
15 deep aquifer with low water yields and poor water quality exists below the Pierre Shale that may
16 be suitable for injection of leaching solutions.

17 18 4.4.4.2.3 Aquifer Restoration Impacts to Groundwater

19
20 The potential environmental impacts to groundwater resources during aquifer restoration are
21 related to groundwater consumptive use and waste management practices, including discharge
22 of wastes to evaporation ponds, land application of treated waste water, and potential deep
23 disposal of brine slurries resulting from reverse osmosis. In addition, aquifer restoration directly
24 affects groundwater quality in the vicinity of the wellfield being restored.

25
26 Aquifer restoration typically involves a combination of the following methods: (1) groundwater
27 transfer, (2) groundwater sweep, (3) reverse osmosis with permeate injection, and
28 (4) groundwater recirculation. These methods are discussed in more detail in Section 2.5. In
29 addition to these processes, potential new restoration processes are being developed. These
30 processes include the use of controlled biological reactions to precipitate uranium and other
31 contaminants by restoring chemically reducing conditions to production aquifers. However,
32 these processes have not yet been used at a commercial scale, and their likely impacts will not
33 be known until the processes have been developed further.

34
35 Groundwater consumptive use for groundwater transfer would be minimal, because milling-
36 affected water in the restoration well field is displaced with baseline quality water from outside
37 the well field. Groundwater consumptive use would be large for groundwater sweep, because it
38 involves pumping groundwater from well field without injection. The rate of groundwater
39 consumptive use would be lower during the reverse osmosis phase, because approximately 70
40 percent of the pumped groundwater treated with reverse osmosis can be re-injected into the
41 aquifer. Groundwater consumptive use could be further decreased during the reverse osmosis
42 phase if brine concentration is used, in which case up to 99 percent of the withdrawn water
43 could be suitable for re-injection. In that case, the actual amount of water that is re-injected into
44 the well field may be limited by the need to maintain a negative water balance to achieve the
45 desired flow of water from outside of the well field into the well field.

46
47 Groundwater consumptive use during aquifer restoration is generally reported to be greater than
48 during ISL operations (Freeman and Stover, 1999; NRC, 2003; Chapter 2 of this GEIS). One
49 reason for increased consumptive use during restoration is that, as previously discussed, no
50 water is re-injected during groundwater sweep. Water is not re-injected during groundwater

1 sweep because the purpose of the sweep phase is to remove contaminated water from a well
2 field and draw unaffected water into the well field. For example, at the Irigaray Mine in
3 Campbell County, Wyoming, between 1.4 and 4.2 pore volumes of water were removed from six
4 restoration units (comprising nine well fields, some of which were combined for restoration).
5 The total volume of water consumed to perform groundwater sweep on all of the wellfields was
6 545 million L [144 million gal].
7

8 As discussed in Section 2.5, restoration typically is performed as well fields end production, so
9 all of the well fields do not undergo groundwater sweep at the same time. For example, at the
10 Irigaray Mine, (COGEMA Mining, Inc., 2004), average pumping rates for groundwater sweep
11 ranged from approximately 100 L/min [27 gal/min] to pump 120 million L [31 million gal] from
12 two well fields between June 1991 and August 1993 to 380 L/min [100 gal/min] to pump 190
13 million L [49 million gal] from three well fields between May of 1990 and April of 1991. At the
14 Smith Ranch/Highland Uranium Project in Converse County, Wyoming, an average pumping
15 rate of approximately 38 L/min [10 gal/min] was used to pump 3.2 pore volumes (49 million L
16 [13 million gal]) from the A-Wellfield during almost 3 years groundwater sweep (Power
17 Resources, Inc., 2004).
18

19 The actual rate of groundwater consumption at an ISL facility at any time depends, in part, on
20 the various stages of operation and restoration of the individual well fields at the facility. For
21 example, consider a hypothetical case in which three well fields at a site undergo groundwater
22 sweep while three undergo reverse osmosis treatment with permeate re-injection and another
23 three continue production. Hypothetically, while 380 L/min [100 gal/min] are consumed during
24 groundwater sweep of three well fields, 110 L/min [30 gal/min] may be consumed to perform
25 reverse osmosis treatment in another three wellfields, and another 38 L/min [10 gal/min] may be
26 consumed by production bleed in the remaining three well fields. The total water consumption
27 rate while these processes continued would be 530 L/min [140 gal/min].
28

29 At a rate of 530 L/min [140 gal/min], 280 million L [74 million gal] would be consumed in one
30 year. For comparison, in 2000, approximately 5.16×10^{11} L [418,000 acre-ft] of water was used
31 to irrigate 143,000 ha [354,000 acres] of land in South Dakota (Hutson *et al.*, 2004). This
32 irrigation rate is equivalent to an annual application of approximately 3.60 million L per hectare
33 [1.18 acre-ft/acre]. Similarly, the average irrigation rate (for irrigated land) in Nebraska is 3.84
34 million L per hectare [1.26 acre-ft/acre] (Hutson *et al.*, 2004). Thus, the consumptive use of 280
35 million L [74 million gal] is roughly equivalent to the water used to irrigate 78 ha [190 acres] in
36 South Dakota or 73 ha [180 acres] in Nebraska for one year.
37

38 Potential environmental impacts are affected by the restoration techniques chosen, the severity
39 and extent of the contamination, and the current and future use of the production and
40 surrounding aquifers in the vicinity of the ISL facility. The potential environmental impacts of
41 groundwater consumptive use during restoration could be SMALL to MODERATE. Site-specific
42 impacts also would depend on the proximity of water users' wells to the well fields, the total
43 volume of water in the aquifer, the natural recharge rate of the production aquifer, the
44 transmissivity and storage coefficient of the production aquifer, and the degree of isolation of the
45 production aquifer from aquifers above and below.
46

47 During aquifer restoration, the most heavily contaminated groundwater may be disposed
48 through the wastewater treatment system. The impacts of discharging wastes to solar
49 evaporation ponds or applying treated wastewater to land during restoration are expected to be

1 similar to the impacts of these waste management practices during operations (SMALL)
2 (Section 4.4.4.2.2.1).

3
4 As discussed in Section 4.2.4.2.2.3, underground injection of fluid requires a permit from the
5 U.S. EPA or authorized State and approval from the NRC. Additionally, the briny slurry
6 produced during reverse osmosis process may be pumped to a deep well for disposal (Section
7 2.7.2). The deep aquifers suitable for injections must have poor water quality, low water yields,
8 or be economically infeasible for production. They also need to be hydraulically separated from
9 overlying aquifer systems. Under these conditions, the potential environmental impacts would
10 be SMALL.

11
12 Aquifer restoration processes also affect groundwater quality directly by removing contaminated
13 groundwater from wellfields, re-injecting treated water, and re-circulating groundwater. In
14 general, aquifer restoration is continued until NRC and applicable state requirements for
15 groundwater quality are met. As discussed in Section 4.3.4.2.2.2, NRC licensees are required
16 to restore the production aquifer to baseline or pre-operational class-of-use conditions, if
17 possible. If the aquifer cannot be returned to pre-operational conditions, NRC requires that the
18 production aquifer be returned to the maximum contaminant levels provided in Table 5C of 10
19 CFR 40 Appendix A or to Alternate Concentration Limits (ACL) approved by the NRC. Historical
20 information about aquifer restoration at several NRC-licensed facilities is discussed in Section
21 2.11.5.

22 23 4.4.4.2.4 Decommissioning Impacts to Groundwater

24
25 The environmental impacts to groundwater during dismantling and decommissioning ISL
26 facilities are primarily associated with consumptive use of groundwater, potential spills of fuels
27 and lubricants, and well abandonment. The consumptive groundwater use could include water
28 use for dust suppression, re-vegetation, and reclaiming disturbed areas (Section 2.6). The
29 potential environmental impacts during the decommissioning phase are expected to be similar
30 to potential impacts during the construction phase. Groundwater consumptive use during the
31 decommissioning activities would be less than groundwater consumptive use during ISL
32 operation and groundwater restoration activities. Spills of fuels and lubricants during
33 decommissioning activities could impact shallow aquifers. Implementation of best management
34 practices (Chapter 7) during decommissioning can help to reduce the likelihood and magnitude
35 of such spills. Based on consideration of best management practices to minimize water use and
36 spills, impacts on the groundwater resources in shallow aquifers from decommissioning would
37 be expected to be SMALL.

38
39 After ISL operations are completed, improperly abandoned wells could impact aquifers above
40 the production aquifer by providing hydrologic connections between aquifers. As part of the
41 restoration and reclamation activities, all monitor, injection, and recovery wells will be plugged
42 and abandoned. The wells will be filled with cement and clay and then cut off below plough
43 depth to ensure that no groundwater flows through the abandoned wells (Stout and Stover,
44 1997). If this process is properly implemented and the abandoned wells are properly isolated
45 from the flow domain, the potential environmental impacts would be SMALL.

1 **4.4.5 Ecological Resources Impacts**

2
3 **4.4.5.1 Construction Impacts to Ecological Resources**

4
5 **Vegetation**

6
7 Because the ecoregions identified in the Nebraska-South Dakota-Wyoming Uranium Milling
8 Region are similar to those found in the Wyoming West Uranium Milling Region, potential
9 impacts to terrestrial vegetation from ISL uranium recovery facility construction would be
10 (SMALL to MODERATE), as described in Section 4.2.5.

11
12 **Wildlife**

13
14 Because of similar ecoregions, , potential impacts of ISL uranium recovery facility construction
15 on terrestrial wildlife identified in the Nebraska-South Dakota-Wyoming Uranium Milling Region
16 would be similar to those found in the Wyoming West Uranium Milling Region (SMALL to
17 MODERATE), as described in Section 4.2.5.

18
19 Disturbed areas would be re-vegetated with a seed mixture of grasses, forbs, and shrubs
20 approved by the WDEQ Land Quality Division, South Dakota Department of Environment and
21 Natural Resources, and Nebraska Department on Environmental Quality to mitigate potential
22 impacts to wildlife and habitat after construction of the well-fields and facility infrastructure.

23
24 Crucial wintering and yearlong ranges vital for survival of local populations of big game and
25 sage grouse leks or breeding ranges are also located within the Wyoming portion of the region
26 (Figures 3.4-12 through 3.4-18). If a potential ISL were to be located within these ranges,
27 guidelines have been issued by the Wyoming Game and Fish Department (2006) for the
28 development of oil and gas resources which could be applied to construction activities
29 associated with an ISL facility. Consultation with the Wyoming Game and Fish Department
30 should be conducted, as well as a site-specific analysis to determine potential impacts from the
31 facility to these species if located in Wyoming.

32
33 **Aquatic**

34
35 Impacts from an ISL uranium recovery facility construction to aquatic resources would be similar
36 to those found in the Wyoming West Uranium Milling Region.

37
38 **Threatened and Endangered Species**

39
40 Numerous threatened and endangered species, as well as state species of concern are located
41 within the region. These species with habitat descriptions are provided in Section 3.4.5.3. After
42 a site has been selected, the habitats and impacts would be evaluated for federal and state
43 species of concern that may inhabit the area. For site-specific environmental reviews, licensees
44 and NRC staff would consult with the U.S. Fish and Wildlife Service, Wyoming Game and Fish
45 Department, South Dakota Game and Fish Department and the Nebraska Game and Park
46 Commission for potential survey requirements and explore ways to protect these resources. If
47 any of the species are identified in a project site during surveys, impacts could range from
48 SMALL to MODERATE to LARGE depending on site-specific conditions. Mitigation plans to
49 avoid and reduce impacts to the potentially affected species would be expected to be

1 developed. These endangered and threatened species have been reported in the Nebraska-
2 South Dakota-Wyoming Uranium Milling Region and have been discussed previously in the
3 Wyoming West Uranium Milling Region in Section 4.2.5.1.

- 4
- 5 • Black Footed Ferret
- 6 • Blowout Penstemon
- 7 • Interior Least Tern
- 8 • Piping Plover
- 9 • Pallid Sturgeon
- 10 • Ute Ladies' Tresses
- 11 • Western Prairie Fringed Orchid
- 12 • Whooping Crane

13

14 **4.4.5.2 Operation Impacts to Ecological Resources**

15

16 Because much less land disturbance would be anticipated during operations phase at an ISL
17 facility, potential impacts to ecological resources from the operation of a ISL facility would be
18 SMALL, and similar to those discussed in the Wyoming West Uranium Milling Region.

19

20 **4.4.5.3 Aquifer Restoration Impacts to Ecological Resources**

21

22 Because the existing infrastructure would be used during aquifer restoration and no additional
23 construction expected, potential impacts to ecological resources would be similar to those of
24 facility operation and therefore, would be SMALL.

25

26 **4.4.5.4 Decommissioning Impacts to Ecological Resources**

27

28 Because the ecoregions are similar, the types of potential impacts to ecological resources from
29 the operation of an ISL facility would be expected to be similar to those discussed in the
30 Wyoming West Uranium Milling Region (SMALL). Additional land-disturbing activity would be
31 less than expected during the construction phase, and would be evaluated during the site-
32 specific environmental review.

33

34 **4.4.6 Air Quality Impacts**

35

36 For the Nebraska-South Dakota-Wyoming Uranium Milling Region, the types of potential non-
37 radiological air impacts for activities conducted as part of all four uranium milling phases would
38 be similar to the impacts described for the Wyoming West Uranium Milling Region in Section
39 4.2.6. The Nebraska-South Dakota-Wyoming Uranium Milling Region analyses in this section is
40 limited to modifying, supplementing, or summarizing the Wyoming West Uranium Milling Region
41 analyses that is presented in Section 4.2.6, as appropriate.

42

43 In general, ISL milling facilities are not major non-radiological air emission sources, and the
44 impacts would be classified as SMALL if the following conditions are met:

- 45
- 46 • Gaseous emissions are within regulatory limits and requirements
- 47
- 48 • Air quality in the region of influence is in compliance with NAAQS
- 49

- 1 • The facility is not classified as a major source under the New Source Review or
2 operating (Title V) permit programs described in Section 1.7.2
3

4 The Nebraska-South Dakota-Wyoming Uranium Milling Region is classified as in attainment for
5 NAAQS (see Figure 3.4-19). This also includes the counties immediately surrounding this
6 region. The Nebraska-South Dakota-Wyoming Uranium Milling Region does include Wind Cave
7 National Park that is classified as a Prevention of Significant Deterioration (PSD) Class I area
8 (see Figure 3.4-20). Current information indicates that the three uranium districts in the region
9 are at least 40 km [25 mi] from Wind Cave, but if the air quality region of influence for a potential
10 ISL facility includes this Class I area, then the more stringent Class I allowable increments
11 would apply.
12

13 4.4.6.1 Construction Impacts to Air Quality 14

15 Non-radiological gaseous emissions in the construction phase include fugitive dust and
16 combustion emissions (see Section 2.7.1). Most of the combustion emissions are diesel
17 emissions, and are expected to be limited in duration to construction activities and result in
18 small, short-term effects. For the purposes of evaluating potential impacts to air quality for a
19 large, commercial-scale ISL facility, Table 2.7-2 contains the annual total releases and average
20 air concentrations of particulate (fugitive dust) and gaseous (diesel combustion products)
21 emissions estimated for the construction phase of the ISL facility proposed for Crownpoint, New
22 Mexico as documented in NRC (1997). The annual average particulate (fugitive dust)
23 concentration was estimated to be $0.28 \mu\text{g}/\text{m}^3$ [$8 \times 10^{-9} \text{ oz}/\text{yd}^3$] (NRC, 1997). However, this
24 estimate did not categorize the particulates as PM_{10} or $\text{PM}_{2.5}$. This estimate is under two
25 percent of the federal $\text{PM}_{2.5}$ ambient air standard, under one percent of the previous federal and
26 current Nebraska and Wyoming PM_{10} ambient air standards, seven percent of the Class I
27 Prevention of Significant Deterioration allowable increment, and under two percent of the
28 Class II Prevention of Significant Deterioration allowable increment. The annual average sulfur
29 dioxide concentration was estimated to be $0.18 \mu\text{g}/\text{m}^3$ [$5 \times 10^{-9} \text{ oz}/\text{yd}^3$] (NRC, 1997). This
30 estimate is less than one percent of both the federal and more restrictive Wyoming ambient air
31 standards, nine percent of the Class I Prevention of Significant Deterioration allowable
32 increment, and under one percent of the Class II Prevention of Significant Deterioration
33 allowable increment. Finally, the annual average nitrogen oxide concentration was estimated to
34 be $2.1 \mu\text{g}/\text{m}^3$ [$5.8 \times 10^{-8} \text{ oz}/\text{yd}^3$] (NRC, 1997). This estimate is about 2 percent of the federal
35 and state ambient air standards, 84 percent of the Class I Prevention of Significant Deterioration
36 allowable increment, and under 9 percent of the Class II Prevention of Significant Deterioration
37 allowable increment.
38

39 The Nebraska-South Dakota-Wyoming Uranium Milling Region is in attainment for NAAQS.
40 This region does contain a PSD Class I area. There is a potential for elevated nitrogen oxide
41 emission levels (see the levels estimated for the proposed Crownpoint ISL facility). However,
42 the majority of the Nebraska-South Dakota-Wyoming Uranium Milling Region is categorized as
43 a Class II area and gaseous emission levels from an ISL facility are expected to comply with
44 applicable regulatory limits and restrictions. Therefore, construction impacts to air quality from
45 constructing ISL facilities would be SMALL.
46

1 **4.4.6.2 Operation Impacts to Air Quality**
2

3 Operating ISL facilities are not major point source emitters and are not expected to be classified
4 as major sources under the operation (Title V) permitting program (Section 1.7.2). One
5 gaseous emission source introduced in the operational phase is the release of pressurized
6 vapor from well field pipelines. Excess vapor pressure in these pipelines could be vented at
7 various relief valves throughout the system. In addition, ISL operations may release gaseous
8 effluents during resin transfer or elution. In general, non-radiological emissions from pipeline
9 system venting, resin transfer, and elution are SMALL. Gaseous effluents produced during
10 drying yellowcake operations vary based on the particular drying technology. Filters and
11 baghouses are used to limit particulate emissions. In general, non-radiological emissions from
12 yellowcake drying would be SMALL.

13
14 Other potential operation phase non-radiological air quality impacts include fugitive dust and
15 vehicle emissions from many of the same sources identified for the construction phase. ISL
16 operations phase fugitive dust emissions sources would be expected to include onsite traffic
17 related to operations and maintenance, employee traffic to and from the site, and heavy truck
18 traffic delivering supplies to the site and product from the site. ISL operations phase would use
19 the existing infrastructure and emissions would not include fugitive dust and diesel emissions
20 associated with well field construction. Therefore, operations phase impacts would be less than
21 the construction phase impacts.

22
23 The Nebraska-South Dakota-Wyoming Uranium Milling Region is currently in NAAQS
24 attainment. This region does, however, contain a PSD Class I area at Wind Cave National
25 Park. There is a potential for elevated nitrogen oxide emission levels (see the levels estimated
26 for the proposed Crownpoint ISL facility). However, as discussed previously, current
27 information indicates that the closest potential ISL facility is at least 40 km [25 mi] from Wind
28 Cave, and the majority of the Nebraska-South Dakota-Wyoming Uranium Milling Region is
29 categorized as a Class II area. Gaseous emission levels from an ISL facility are expected to
30 comply with applicable regulatory limits and restrictions. These emissions are not expected to
31 reach levels that result in the ISL facility being classified as a major source under the operating
32 (Title V) permit process. Therefore, operation impacts for ISL facilities would be SMALL.

33
34 **4.4.6.3 Aquifer Restoration Impacts to Air Quality**
35

36 Potential non-radiological air quality impacts from aquifer restoration activities (Section 2.11.5)
37 include fugitive dust and combustion emissions from many of the same sources identified
38 previously for the operations phase. The plugging and abandonment of production and injection
39 wells use equipment that generates gaseous emissions. These emissions would be expected
40 to be limited in duration and result in SMALL, short-term effects. ISL aquifer restoration phase
41 would use the existing infrastructure and the impacts would not be expected to exceed those of
42 the construction phase. Therefore, aquifer restoration phase impacts would be SMALL.

43
44 **4.4.6.4 Decommissioning Impacts to Air Quality**
45

46 Potential decommissioning phase non-radiological air impacts include fugitive dust, vehicle
47 emissions, and diesel emissions from many of the same sources identified previously for the
48 construction phase. In the short-term emission levels could increase, especially for particulate
49 matter from activities such as dismantling buildings and milling equipment, removing any
50 contaminated soil, and grading the surface as part of reclamation activities. Decommissioning

1 phase impacts would be expected to be similar to construction phase impacts and decrease as
2 decommissioning and reclamation activities are completed. Therefore, decommissioning phase
3 impacts would be SMALL.

4 **4.4.7 Noise Impacts**

5 **4.4.7.1 Construction Impacts to Noise**

6
7
8
9 For the three uranium districts located in the Nebraska-South Dakota-Wyoming Uranium Milling
10 Region, potential noise impacts during well field construction, drilling, and facility construction
11 would be similar to the impacts described for the Wyoming West Uranium Milling Region in
12 Section 4.2.7.1. There are additional sensitive areas that would be considered within this region
13 (see Section 3.4.7), but because of decreasing noise levels with distance, construction activities
14 would be expected to have only SMALL and temporary noise impacts for residences,
15 communities, or sensitive areas located more than about 300 m [1,000 ft] from specific noise
16 generating activities. The noise impacts associated with constructing either a central or satellite
17 production facility would be of short duration compared to the operations period. Noise impacts
18 to workers during construction would be SMALL because of compliance with Occupational
19 Safety and Health Administration noise regulations. During construction, wildlife would be
20 anticipated to avoid areas where noise-generating activities are ongoing. Therefore, overall
21 noise impacts during construction would be SMALL to MODERATE.

22 **4.4.7.2 Operation Impacts to Noise**

23
24
25 For the three uranium districts located in the Nebraska-South Dakota-Wyoming Uranium Milling
26 Region, potential noise impacts during ISL operations would be similar to the impacts described
27 for the Wyoming West Uranium Milling Region in Section 4.2.7.2. There are additional sensitive
28 areas that should be considered within this region (see Section 3.4.7), but because of
29 decreasing noise levels with distance, operations at facilities more than 300 m [1,000 ft] from
30 the nearest residence, community, or sensitive area would be expected to have only SMALL
31 noise impacts. Because the same infrastructure would be used, noise generating activities
32 during aquifer restoration would be similar to the operation phase. Noise impacts to workers
33 during operations would be SMALL because of compliance with Occupational Safety and Health
34 Administration noise regulations. During operations, wildlife are anticipated to avoid areas
35 where noise-generating activities were ongoing. Compared to existing traffic counts, truck traffic
36 associated with yellowcake and chemical shipments and traffic noise related to commuting
37 would have a SMALL, temporary impact on communities located along the existing roads.
38 Some country roads with the lowest average annual daily traffic counts would be expected to
39 have higher relative increases in traffic and noise impacts, in particular, when facilities are
40 experiencing peak employment (these impacts would be MODERATE). Therefore, overall noise
41 impacts during operations would be SMALL to MODERATE.

42 **4.4.7.3 Aquifer Restoration Impacts to Noise**

43
44
45 For the three uranium districts located in the Nebraska-South Dakota-Wyoming Uranium Milling
46 Region, potential noise impacts during aquifer restoration would be similar to the impacts
47 described for the Wyoming West Uranium Milling Region in Section 4.2.7.3. There are
48 additional sensitive areas that should be considered within this region (see Section 3.4.7), but
49 because of decreasing noise levels with distance, aquifer restoration activities at facilities more

1 than 300 m [1,000 ft] from the nearest residence, community, or sensitive area would have only
2 SMALL noise impacts. Noise impacts to workers during aquifer restoration would also be
3 SMALL because of compliance with Occupational Safety and Health Administration noise
4 regulations. During aquifer restoration, wildlife are anticipated to avoid areas where noise-
5 generating activities are ongoing. Therefore, overall noise impacts during aquifer restoration
6 would be SMALL to MODERATE.

7 8 **4.4.7.4 Decommissioning Impacts to Noise**

9
10 For the three uranium districts located in the Nebraska-South Dakota-Wyoming Uranium Milling
11 Region, potential noise impacts during aquifer restoration would be similar to the impacts
12 described for the Wyoming West Uranium Milling Region in Section 4.2.7.4. There are
13 additional sensitive areas that should be considered within this region (see Section 3.4.7), but
14 for facilities more than 300 m [1,000 ft] from the nearest residence, community, or sensitive area
15 decommissioning would have only SMALL noise impacts. Noise impacts to workers during
16 decommissioning would also be SMALL because of compliance with Occupational Safety and
17 Health Administration noise regulations. During decommissioning, wildlife would be anticipated
18 to temporarily avoid areas where noise-generating activities are ongoing. Therefore, overall
19 noise impacts during decommissioning would be SMALL.

20 21 **4.4.8 Historical and Cultural Resources Impacts**

22
23 Construction-related impacts to cultural resources (defined here as historical, cultural,
24 archaeological, and traditional cultural properties) can be direct or indirect and can occur at any
25 stage of an ISL uranium recovery facility project (i.e., during construction, operation, aquifer
26 restoration, and decommissioning).

27
28 A general cultural overview of the affected environment for the Nebraska-South Dakota-
29 Wyoming Uranium Milling Region is provided in Sections 3.2.8 and 3.4.8 of this GEIS.
30 Construction involving land disturbing activities, such as grading roads, installing wells and
31 constructing surface facilities and well fields, are expected to be the most likely to affect cultural
32 and historical resources. Prior to engaging in land disturbing activities, licensees and applicants
33 would review existing literature and perform region-specific records searches to determine
34 whether cultural or historical resources are present and have the potential to be disturbed.
35 Along with literature and records reviews, the project site area and all its related facilities and
36 components would be subjected to a comprehensive cultural resources inventory (performed by
37 the licensee or applicant) that meets the requirements of responsible federal, state, and local
38 agencies (e.g., the Nebraska, South Dakota, or Wyoming SHPO). The literature and records
39 searches would help identify known or potential cultural resources and Native American sites
40 and features. The cultural resources inventory would identify the previously documented sites
41 and any newly identified cultural resources sites. The eligibility evaluation of cultural resources
42 for listing in the NRHP under criteria in 36 CFR 60.4(a)–(d) and/or as Traditional Cultural
43 Properties is conducted as part of the site-specific review and NRC licensing procedures
44 undertaken during the NEPA review process. The evaluation of impacts to any historic
45 properties designated as Traditional Cultural Properties and tribal consultations regarding
46 cultural resources and Traditional Cultural Properties also occur during the site-specific
47 licensing application and review process. Consultation to determine whether significant cultural
48 resources would be avoided or mitigated would occur during consultations with the other
49 agencies, state SHPO, and tribal representatives as part of the site-specific review.

1 Additionally, as needed, the NRC license applicant would be required, under conditions in its
2 NRC license, to adhere to procedures regarding the discovery of previously undocumented
3 cultural resources during initial construction, operation, aquifer restoration, and
4 decommissioning. These procedures typically require the licensee to stop work and to notify the
5 appropriate federal and state agencies.

6
7 Licensees and applicants typically consult with the responsible state and tribal agencies to
8 determine the appropriate measures to take (e.g., avoidance or mitigation) should new
9 resources be discovered during land disturbing activities at a specific ISL facility. NRC and
10 licensees/applicants may enter into a memorandum of agreement with the responsible state and
11 tribal agencies to ensure protection of historical and cultural resources, if encountered.

12 13 **4.4.8.1 Construction Impacts to Historical and Cultural Resources**

14
15 Most of the potential for significant adverse effects to NRHP-eligible or potentially NRHP-eligible
16 historic properties and traditional cultural properties, both direct and indirect, would likely occur
17 during land-disturbing activities related to building an ISL uranium recovery facility. Buried
18 cultural features and deposits that are not visible on the surface during initial cultural resources
19 inventories could be discovered during earth-moving activities.

20
21 Indirect impacts may also occur outside the ISL uranium recovery project site and related
22 facilities and components. Visual intrusions (see Section 4.4.9.1), increased access to formerly
23 remote or inaccessible resources, impacts to traditional cultural properties and culturally
24 significant landscapes, as well as other ethnographically significant cultural landscapes may
25 adversely affect these resources. These significant cultural landscapes should be identified
26 during literature and records searches and may require additional archival, ethnographic, or
27 ethno-historical research that encompasses areas well outside the area of direct impacts.
28 Indirect impacts to some of these cultural resources may be unavoidable and exist throughout
29 the lifecycle of an ISL uranium recovery project.

30
31 Because of the localized nature of land disturbing activities related to construction, impacts to
32 cultural and historical resources are anticipated to be SMALL, but could be MODERATE to
33 LARGE if the facility is located adjacent to a known resource. Wyoming historical sites listed in
34 the NRHP and traditional cultural properties are provided in Section 3.2.8 of this GEIS. South
35 Dakota and Nebraska historical sites and traditional cultural properties are described in Section
36 3.4.8. Additional sensitive areas include properties under the management of the National Park
37 Service such as Devils Tower, Jewel Cave, and Mt. Rushmore National Monuments, and Wind
38 Cave National Park. Proposed facilities or expansions adjacent to these properties are likely to
39 have the greatest potential impacts, and mitigation measures (e.g., avoidance, recording and
40 archiving samples) and additional consultations with the appropriate state (Wyoming, South
41 Dakota, or Nebraska) SHPO and affected Native American tribes would be needed to assist in
42 reducing the impacts. From the standpoint of cultural resources, the most significant impacts to
43 any sites that are present will occur during the initial construction within the area of potential
44 effect. Subsequent changes in the footprint of the project, that is, expansion outside of the
45 original area of potential effect, may also result in significant impacts to cultural resources that
46 might be present.

1 **4.4.8.2 Operation Impacts to Historical and Cultural Resources**

2
3 Depending on the location, impacts to NRHP-eligible, potentially NRHP-eligible historical
4 properties, traditional cultural properties, and other cultural resources are possible during
5 operation of an ISL uranium recovery project. Potential impacts during operation are expected
6 to occur through new earth-disturbing activities, new construction, maintenance and repair.
7 Because less earth-disturbing activities are expected during operations, potential impacts would
8 be SMALL (less than during construction). The three uranium districts in the Nebraska-South
9 Dakota-Wyoming Uranium Milling Region are located more than 16 km [10 mi] from these
10 sensitive areas, further reducing potential impacts.

11
12 Inadvertent impacts to historic and cultural resources located within the extended ISL permitted
13 area and other cultural landscapes that are identified before construction are expected to
14 continue during operation. Overall impacts to cultural and historical resources during operations
15 are expected to be less than those during construction, as operations are generally limited to
16 previously disturbed areas (e.g., access roads, central processing facility, well sites), and would
17 be SMALL.

18
19 **4.4.8.3 Aquifer Restoration Impacts to Historical and Cultural Resources**

20
21 Depending on the location, both direct and indirect adverse effects on NRHP-eligible, potentially
22 NRHP-eligible historical properties, traditional cultural properties, and other cultural resources
23 are possible during the aquifer restoration phase of an ISL uranium recovery project. Potential
24 impacts during aquifer restoration may occur through new earth-disturbing activities or other
25 new construction that may be required for the restoration process. Such activities may have
26 inadvertent impacts to cultural resources and traditional cultural properties in or near the site of
27 aquifer restoration activities located within the extended ISL project area.

28
29 Inadvertent impacts to historic and cultural resources located within the extended ISL permitted
30 area and other cultural landscapes that are identified before construction are expected to
31 continue during aquifer restoration. Overall impacts to cultural and historical resources during
32 aquifer restoration are expected to be less than those during construction, as aquifer restoration
33 activities are generally limited to previously disturbed areas (e.g., access roads, central
34 processing facility, well sites), and would be SMALL.

35
36 **4.4.8.4 Decommissioning Impacts to Historical and Cultural Resources**

37
38 Depending on the location, both direct and indirect adverse effects on NRHP-eligible, potentially
39 NRHP-eligible historical properties, traditional cultural properties, and other cultural resources
40 are possible during the decommissioning phase of an ISL uranium recovery project. Potential
41 impacts can result from earth-disturbing activities that may be required for the decommissioning
42 process. Inadvertent impacts to cultural resources and traditional cultural properties in or near
43 the site of decommissioning activities may potentially occur.

44
45 Inadvertent impacts to historic and cultural resources located within the extended ISL permitted
46 area and other cultural landscapes that are identified before construction are expected to
47 continue during aquifer restoration. Overall impacts to cultural and historical resources during
48 decommissioning are expected to be less than those during construction, as decommissioning
49 activities are generally limited to previously disturbed areas (e.g., access roads, central
50 processing facility, well sites). Impacts to previously known historical, cultural, archaeological

1 and traditional cultural properties documented during the initial inventory during
2 decommissioning can result from earth-disturbing activities that may be required for the
3 decommissioning process. Because cultural resources within the existing area of potential
4 effect are known, potential impacts can be avoided or lessened by redesign of decommissioning
5 project.
6

7 **4.4.9 Visual/Scenic Resources Impacts**

8 **4.4.9.1 Construction Impacts to Visual/Scenic Resources**

10
11 During construction, most impacts to visual resources in the Nebraska-South Dakota-Wyoming
12 Uranium Milling Region would be similar to those in the Wyoming West Uranium Milling Region.
13 Most visual and scenic impacts associated with drilling and other land-disturbing construction
14 activities would be temporary. Roads and structures would be more long-lasting, but would be
15 removed and reclaimed after operations cease. As noted in Section 3.4.9, most of the areas in
16 the Nebraska-South Dakota-Wyoming Uranium Milling Region are identified as VRM Class II
17 through Class IV according to the BLM classification system or as having a low to moderate
18 scenic integrity objective classification according to the USFS classification system. As
19 described in Section 3.4.9, there are a number of potentially sensitive visual resources in the
20 Nebraska-South Dakota-Wyoming Uranium Milling Region. The existing and potential ISL
21 facilities identified in the three uranium districts of the Nebraska-South Dakota-Wyoming
22 Uranium Milling Region are generally located more than 16 km [10 mi] from VRM Class II areas
23 and 40 km [25 mi] from the Prevention of Significant Deterioration Class I area located at Wind
24 Cave National Park. The existing Crow Butte ISL facility in Dawes County, Nebraska is located
25 near the Pine Ridge unit of the Nebraska National Forest, but it has been in operation since the
26 late 1980s and is an established part of the landscape. Visual/scenic impacts introduced by
27 construction activities in these areas would be SMALL and reduced further through best
28 management practices (e.g., dust suppression).
29

30 **4.4.9.2 Operation Impacts to Visual/Scenic Resources**

31
32 Similar to the visual impacts described for the Wyoming West Uranium Milling Region discussed
33 in Section 4.2.9.2, the potential visual and scenic impacts from ISL operations in the
34 Nebraska-South Dakota-Wyoming Uranium Milling Region would be SMALL and the same as or
35 less than those impacts associated with construction. The greatest potential for visual impacts
36 would be for new facilities operating in rural, previously undeveloped areas or within view of the
37 sensitive regions described in Section 3.4.9. Given the distances of existing and potential
38 uranium ISL facilities from these areas, visual and scenic impacts introduced by ISL operations
39 would be SMALL, and reduced further through best management practices (e.g., dust
40 suppression).
41

42 **4.4.9.3 Aquifer Restoration Impacts to Visual/Scenic Resources**

43
44 Similar to the potential visual impacts described for the Wyoming West Uranium Milling Region
45 discussed in Section 4.2.9.3, the potential visual and scenic impacts from ISL aquifer restoration
46 operations in the Nebraska-South Dakota-Wyoming Uranium Milling Region would be SMALL.
47 Aquifer restoration would not occur until after the facility had been in operation for a number of
48 years, and potential impacts would be the same as or less than during the construction or
49 operations periods. Although overall impacts from aquifer restoration activities would be

1 SMALL, the potential visual impacts would be greatest for facilities located in previously
2 undeveloped areas or within view of the sensitive regions described in Section 3.4.9. Given the
3 distances of existing and potential uranium ISL facilities from these areas, visual and scenic
4 impacts introduced by ISL aquifer restoration activities would be SMALL, and reduced further
5 through best management practices (e.g., dust suppression).
6

7 **4.4.9.4 Decommissioning Impacts to Visual/Scenic Resources**

8

9 Similar to the potential visual impacts described for the Wyoming West Uranium Milling Region
10 discussed in Section 4.2.9.4, the potential visual and scenic impacts from decommissioning and
11 reclaiming ISL facilities in the Nebraska-South Dakota-Wyoming Uranium Milling Region would
12 be SMALL. Decommissioning and reclamation activities would occur after the facility had been
13 in operation for a number of years and one of the purposes of the decommissioning process is
14 to remove surface infrastructure and reclaim the area to pre-operational conditions. This would
15 result in less visual contrast for the facility. Although overall impacts from decommissioning and
16 reclamation activities would be the same as, or less than, those for construction and operation,
17 the potential visual impacts would be greatest for facilities located in previously undeveloped
18 areas, or within view of the sensitive regions described in Section 3.4.9. Given the distances of
19 existing and potential uranium ISL facilities from these areas, visual and scenic impacts
20 introduced by ISL decommissioning and reclamation activities would be SMALL and reduced
21 further through best management practices (e.g., dust suppression).
22

23 **4.4.10 Socioeconomic Impacts**

24

25 Although a proposed facility size and production level can vary, the peak annual employment at
26 an ISL facility range up to about 200 people, including construction (Freeman and Stover, 1999;
27 NRC, 1997; Energy Metals Corporation, U.S., 2007). The workforce in this region frequently
28 commutes long distances, many times out-of-state. Depending on the composition and size of
29 the local workforce, overall socioeconomic impacts from ISL milling facilities for the Nebraska-
30 South Dakota-Wyoming Uranium Milling Region would range from SMALL to MODERATE.
31

32 Assuming the number of persons per household in Nebraska-South Dakota-Wyoming Uranium
33 Milling Region is similar to that of the US, the number is about 2.5 (U.S. Census Bureau, 2008).
34 As a result, the number of people associated with an ISL facility workforce could be as many as
35 500 (i.e., 200 workers times 2.5 persons/household). The demand for public services (schools,
36 police, fire, emergency services) would be expected to increase with the construction and
37 operation of an ISL facility. There may also be additional standby emergency services not be
38 available in some parts of the region. It may be necessary to develop contingency plans and/or
39 additional training for specialized equipment. Infrastructure (streets, waste management,
40 utilities) for the families of a workforce of this size would also be affected.
41

42 **4.4.10.1 Construction Impacts to Socioeconomics**

43

44 The majority of construction requirements would likely be filled by a skilled workforce from
45 outside of the Nebraska-South Dakota-Wyoming Uranium Milling Region. Assuming a peak
46 workforce of 200, this influx of workers is expected to result in SMALL to MODERATE impact in
47 the Nebraska-South Dakota-Wyoming Uranium Milling Region. Impacts would be greatest for
48 communities with small populations, such as Sioux County, Nebraska (pop. 1,350), Niobrara
49 County, Wyoming, and the towns of Osage, Wyoming (pop. 200) and Hill City, South Dakota

Environmental Impacts of Construction, Operation,
Aquifer Restoration, and Decommissioning Activities

1 (pop. 870). However, due to the short duration of construction (12-18 months), workers would
2 have only a limited effect on public services and community infrastructure. Further, construction
3 workers are less likely to relocate their entire family to the region, thus minimizing impacts from
4 an outside workforce. In addition, if the majority of the construction workforce is filled from
5 within the region, impacts to population and demographics would be SMALL.
6

7 Construction impacts to regional income and the labor force for a single ISL facility in the
8 Wyoming West Uranium Milling Region would likely be SMALL. In addition, even if multiple
9 facilities be developed concurrently, the potential for impact upon the labor force would still be
10 SMALL. Only in Sioux County, Nebraska, with the smallest labor force (749) in the region,
11 would there be a MODERATE to LARGE impact if the entire workforce was to be derived from
12 that county, alone. Construction of an ISL is likely, to the extent possible, to draw upon the
13 labor force within the region before going outside the region (and state). The greatest economic
14 benefit to the region would be to have the labor force drawn from within the region. However,
15 economic benefit may still be achieved (in the form of the purchased of goods and services)
16 even if the labor force is derived from outside the region. The potential impact upon smaller
17 communities (Osage, Wyoming and Hill City, South Dakota) and Sioux County could be
18 MODERATE.
19

20 Impacts to housing from construction activities would be expected to be SMALL (and short-
21 termed) even if the workforce is primarily filled from outside the region. It is likely that the
22 majority of construction workers would use temporary housing such as apartments, hotels, or
23 trailer camps. Many construction workers use personal trailers for housing on short-term
24 projects. Impacts on the region's housing market would, therefore, be considered SMALL.
25 However, the impact upon specific facilities (apartment complexes, hotels, or campgrounds)
26 could potentially be MODERATE, if construction workers concentrated in one general area.
27

28 Assuming the majority of employment requirements for construction are filled by outside
29 workers (a peak of 200), there would be SMALL to MODERATE impacts to employment
30 structure. The use of outside workforce would be expected to have MODERATE impacts to
31 communities with high unemployment rates, such as Laramie, Wyoming, due to the potential
32 increase in job opportunities. If the majority of construction activities rely on the use of a local
33 workforce, impacts would be anticipated to be SMALL to MODERATE depending upon the size
34 of the local workforce. Communities such as Sioux County and the Oglala Sioux Tribe of the
35 Pine Ridge Indian Reservation would experience MODERATE impacts, due to their high
36 unemployment rate and potential increase in employment opportunities.
37

38 Local finance would be affected by ISL construction through additional taxation and the
39 purchase of goods and services. Though Wyoming does not have an income tax, it does have
40 a state sales tax (4 percent), a lodging tax (2-5 percent), and a use tax (5 percent).
41 Construction workers are anticipated to contribute to these as they purchase goods and
42 services within the region and within the state while working on an ISL facility. In addition, and
43 more significant, is the 'ad valorem tax' the state imposes on mineral extraction. In 2007 for
44 uranium, alone, the state collected \$ 17 million from this tax (WY Dept. of Revenue). Sources of
45 Revenue for the State of Nebraska come from the income, sales, cigarette, motor, and lodging
46 taxes. Personal income taxes rates for Nebraska range from 2.56 percent to 6.84 percent. The
47 sales and use tax rates 5.5 percent. Information on "ad valorem (or mineral) taxes" from the
48 extraction of uranium are not available (Nebraska Department of Revenue, 2007). Sources of
49 revenue for the state of South Dakota come from 36 different state taxes, and are grouped into
50 four main categories: 1) sales, use, and contractor's excise taxes; 2) motor fuel taxes; 3) motor

1 vehicles fees and taxes; and 4) special taxes. Once collected, these tax revenues are
2 distributed into the state's general fund, local units of government, and the state highway fund.
3 South Dakota also imposes an energy minerals tax on owners of energy minerals (such as
4 uranium). In 2006, the tax rate base was 4.5 percent of the taxable value and approximately 50
5 percent was dispersed to local government (South Dakota Department of Revenue and
6 Regulation, 2007). It is anticipated that ISL facility development could have a MODERATE
7 impact on local finances within the region.
8

9 Even if the majority of workforce is filled from outside, impacts to education from construction
10 activities would be SMALL. This is because construction workers are less likely to re-locate
11 their entire family for a relatively short duration (12-18 months). Impacts to education from a
12 local workforce would also be SMALL, as they are already established in the community.
13

14 Potential impacts from construction (from either the use of local or outside [non-regional]
15 workforce) to local health services such as hospitals or emergency clinics would be SMALL.
16 Accidents resulting from construction of an ISL facility are not expected to be different than
17 other types of similar industrial facilities.
18

19 4.4.10.2 Operation Impacts to Socioeconomics

20
21 Operational requirements of an ISL necessitate the use of
22 specialized workers, such as plant managers, technical
23 professionals, and skilled tradesmen. While operational
24 activities would be longer term (20-40 years) than
25 construction (12-18 months), instead of up to 200 workers,
26 an operating ISL generally requires a labor force of from
27 50 to 80 personnel. If the majority of operational
28 requirements are filled by a workforce from outside the
29 region, assuming a multiplier of about 0.7 (see text box),
30 there could be an influx of between 35 and 56 jobs (i.e.,
31 $50-80 \times 0.7$) per ISL facility (up to 140, including families).
32

33 The potential impact to the local population and public
34 services resulting from the influx of workers and their families would range from SMALL to
35 MODERATE, depending upon the location (proximity to a population center) of an ISL within the
36 region. However, because an outside workforce would be more likely to settle into more
37 populated areas with increased access to housing, schools, services, and other amenities,
38 these impacts may be reduced. If the majority of labor is of local origin, potential impacts to
39 population and public services would be expected to be SMALL, as the workers would already
40 be established in the region.

41 It is assumed, however, that because of the highly technical nature of ISL operation (requiring
42 professionals in the areas of health physics, chemistry, laboratory analysis, geology and
43 hydrogeology, and engineering), the majority (approximately 70 percent) of the work force (35 to
44 56 personnel) would be staffed from outside the region for, at least, the initial ISL facility.
45 Subsequent ISL facilities may draw personnel from established or decommissioned facilities.
46 This is expected to have a SMALL impact upon the regional labor force.
47

48 If it is assumed that as many as 56 families (80 workers \times 0.7 economic multiplier) are required
49 to relocate into the Nebraska-South Dakota-Wyoming Uranium Milling Region, the most likely
50 available housing markets would be located in the larger communities, such as Spearfish and

Economic Multipliers

The economic multiplier is used to summarize the total impact that can be expected from change in a given economic activity. It is the ratio of total change to initial change. The multiplier of 0.7 was used as a typical employment multiplier for the milling/mining industry (Economic Policy Institute, 2003).

1 Hot Springs in South Dakota (within the region) and Rapid City, South Dakota (located just
2 outside the region). Unless the workforce is distributed throughout the region, the impact of an
3 ISL on the housing market would be MODERATE, depending upon location, due to the limited
4 number of available units.

5
6 Impacts to income and the labor force structure within the Nebraska-South Dakota-Wyoming
7 Uranium Milling Region would be similar to construction impacts, but longer in duration.
8 Impacts from ISL operation would be SMALL to MODERATE, depending on where the majority
9 of the workforce settles (is housed).

10
11 Assuming a local workforce is used, there would be SMALL impacts to the local employment
12 structure, and would be similar to construction impacts. If the entire labor force for the ISL
13 facility came from outside the affected community, the workforce would be SMALL to
14 MODERATE relative to the employment structure for most of the affected counties. Impacts
15 from inflow of an outside workforce would be similar to construction impacts.

16
17 Assuming the majority of workforce is derived from outside the Nebraska-South Dakota-
18 Wyoming Uranium Milling Region, potential impacts to education from operation activities would
19 be SMALL. Even though the number of people associated with an ISL facility workforce could
20 be as much as 140 (including families), there would only be about 30 school-aged children
21 involved. While the influx of new students would be the greatest in the smaller school districts,
22 even in these districts the impacts are anticipated to be SMALL. For example, with the
23 exception of Sioux County, Nebraska, the smaller school districts average about 200-300 pupils
24 per school (Sec 3.4.10.6). Even if all the ISL worker's children attended the same school (which
25 is unlikely), the increase in that school's student population would only be 10-15 percent.

26
27 Effects on other community services (health care, utilities, shopping, recreation, etc.) during
28 operation are anticipated to be similar to construction (less in volume/quantity, but longer in
29 duration). Therefore, the potential impacts would be SMALL.

30 31 **4.4.10.3 Aquifer Restoration Impacts to Socioeconomics**

32
33 The same ISL facility components and workforce would be involved in aquifer restoration as
34 during operations use. Thus, the number of personnel involved would also be the same, and
35 the potential impacts would be similar. These potential impacts would extend beyond the life of
36 the facility (typically 2-10 years), but still would be SMALL.

37
38 Income and labor force requirements during aquifer restoration are anticipated to be the same
39 as during operations (technical requirements are similar), and therefore, potential impacts would
40 be SMALL.

41
42 The employment structure during aquifer restoration would be expected to be unchanged and
43 continue after the operational phase. However, a smaller number of specialized workers may
44 be required to return the site to pre-ISL levels. The potential impacts to the region would be
45 considered SMALL.

46
47 Impacts to housing, education, health, and social services during aquifer restoration would also
48 be expected to be the similar to operations, but continues beyond the life of the site. The overall
49 potential impacts would be SMALL.

1 **4.4.10.4 Decommissioning Impacts to Socioeconomics**

2
3 Decommissioning is, essentially, deconstruction, and is expected to require a similar work force
4 (up to 200 personnel), with similar skills, as the construction phase. The impacts to affected
5 communities in the Nebraska-South Dakota-Wyoming Uranium Recovery Region during
6 decommissioning would, therefore, be similar to the construction phase. The decommissioning
7 phase may last up to a year longer than the construction phase, depending upon the condition
8 of the ISL at termination. However, the overall potential impacts are still expected to be SMALL
9 to MODERATE,

10
11 The income levels and labor force requirements during decommissioning are also anticipated to
12 be similar to the construction phase, and the potential impacts to the region would, therefore, be
13 considered SMALL to MODERATE.

14
15 The employment structure during decommissioning would be similar to the construction phase;
16 however, a reduction of workforce would result towards the end of the decommissioning phase.
17 Impacts to employment would be SMALL to MODERATE.

18
19 Potential impacts to housing during the decommissioning phase would be similar to the
20 construction phase and would be SMALL for the larger communities within the region, but may
21 be MODERATE if the temporary housing was to be concentrated in a smaller community.

22
23 Decommissioning would be expected to involve similar numbers (up to 200) of workers (likely
24 without families) because of the short-duration of the activity) as construction. Therefore, the
25 anticipated impacts to the local education system would be SMALL.

26
27 Impacts to community services (health care, entertainment, shopping, recreation) would also be
28 similar to construction, and thus, would be considered SMALL.

29
30 **4.4.11 Public and Occupational Health and Safety Impacts**

31
32 Licensees are required to implement radiological monitoring and safety programs that comply
33 with 10 CFR Part 20 requirements to protect the health and safety of workers and the public.
34 NRC periodically inspects these programs to ensure compliance.

35
36 **4.4.11.1 Construction Impacts to Public and Occupational Health and Safety**

37
38 Construction impacts on public and occupational health and safety for the Nebraska-South
39 Dakota-Wyoming Uranium Milling Region would be similar to those discussed for the Wyoming
40 West Uranium Milling Region in Section 4.2.11.1.

41
42 **4.4.11.2 Operation Impacts to Public and Occupational Health and Safety**

43
44 **4.4.11.2.1 Radiological Impacts to Public and Occupational Health and Safety From**
45 **Normal Operations**

46
47 Estimated doses to members of the public are reported for a variety of commercial-scale and
48 satellite facilities in section 4.2.11.2.1. As shown, these doses are well below the public dose
49 limit of 1 mSv/yr [100 mrem/yr]. Doses at other locations could be higher or lower depending on

1 a variety of factors including receptor location, topography, and weather conditions. When
2 releases occur from ground level, doses decrease the farther the receptor is away from the
3 release location because the radioactive material is diluted as the wind mixes it. The amount of
4 dilution, which is referred to as dispersion, is determined by the weather (meteorological
5 conditions). For areas in which meteorological conditions are more stable (less turbulent), a
6 higher dose could occur. As the radioactive material travels via the wind, changes in
7 topography can affect the dose received by the receptor. Doses for the various ISL facilities
8 shown in Table 4.2-2 are at least a factor of three below the regulatory limit and most are less
9 than that. Doses at operating ISL facilities in different regions are not likely to exceed regulatory
10 limits, and the overall potential radiological impacts from ISL operations would be SMALL.

11
12 **4.4.11.2.2 Radiological Impacts to Public and Occupational Health and Safety**
13 **From Accidents**

14
15 The consequences of potential accidents are expected to be similar regardless of an ISL
16 facility's location and are described in Section 4.2.11.2.2. Distance to the nearest receptor,
17 topography, and meteorological data account for potential differences in resulting dose. For
18 facilities in which the maximally exposed offsite individual would be closer, there would be
19 higher doses for ground-level releases. Changes in topography could also have an impact on
20 the resulting dose since this would allow the receptor to be closer to, or farther away from, the
21 radioactive material as it travels by wind. Meteorological conditions vary based on location and
22 could result in a higher or lower dose. The consequences resulting from a potential unmitigated
23 accident would have a SMALL impact on the general public and, at most, a MODERATE impact
24 on the workers.

25
26 **4.4.11.2.3 Non-radiological Impacts to Public and Occupational Health and Safety From**
27 **Normal Operations**

28
29 While hazardous chemicals are used at ISL facilities (Section 2.4.2) SMALL risks would be
30 expected in the use and handling of these chemicals during normal operations at ISL facilities.
31 However, accidental releases of these hazardous chemicals can produce significant
32 consequences and impact public and occupational health and safety. An analysis of such
33 hazards and potential risks for impacts is provided in the following section.

34
35 **4.4.11.2.4 Non-radiological Impacts to Public and Occupational Health and Safety**
36 **From Accidents**

37
38 Non-radiological impacts to public and occupational health and safety for the Nebraska-South
39 Dakota-Wyoming Uranium Milling Region are expected to be similar to impacts discussed for
40 the Wyoming West Uranium Milling Region in Section 4.2.11.2.4. Compliance with applicable
41 10 CFR Part 20, EPA, and Occupational Safety and Health Administration requirements would
42 ensure safe handling of radiological and hazardous materials. The likelihood of accidental
43 releases would be reduced, and the potential impacts would be SMALL.

44
45 **4.4.11.3 Aquifer Restoration Impacts to Public and Occupational Health and Safety**

46
47 Aquifer restoration impacts to public and occupational health and safety are expected to be
48 similar to operational impacts discussed in Section 4.4.11.2. Compliance with applicable 10
49 CFR Part 20 (Section 2.9) and Occupational Safety and health Administration requirements
50 would ensure SMALL impacts.

1
2 **4.4.11.4 Decommissioning Impacts to Public and Occupational Health and Safety**
3

4 During ISL decommissioning activities, hazards are removed or reduced, surface soils and
5 structures are decontaminated, and disturbed lands are reclaimed. During these activities,
6 SMALL impacts could occur.
7

8 To ensure safety of workers and the public during decommissioning, the NRC requires licensed
9 facilities to submit a decommissioning plan for review (Section 2.6). Such a plan includes
10 details of how a 10 CFR Part 20 compliant radiation safety program would be implemented
11 during decommissioning to ensure safety of workers and the public is maintained and applicable
12 safety regulations are complied with. A combination of: (1) NRC review and approval of these
13 plans, (2) the application of site-specific license and permit conditions where necessary, and (3)
14 regular NRC and Occupational Safety and Health Administration inspection and enforcement
15 activities to ensure compliance with applicable health and safety requirements constrain the
16 magnitude of potential public and occupational health impacts from ISL facility decommissioning
17 actions to SMALL levels.
18

19 **4.4.12 Waste Management Impacts**
20

21 Waste management impacts for the Nebraska-South Dakota-Wyoming Uranium Milling Region
22 are expected to be similar to the impacts discussed for the Wyoming West Uranium Milling
23 Region in Section 4.2.12. because the waste volumes, management practices, waste
24 management safety and environmental concerns, waste management permitting and
25 regulations, and relevant aspects of the NRC licensing are not expected to change significantly
26 (either in practice or effectiveness) with facility location from one region to another.
27

28 **4.4.12.1 Construction Impacts to Waste Management**
29

30 The relatively small scale of construction activities (Section 2.3) and incremental development
31 of well fields at ISL facilities is expected to generate low volumes of construction waste.
32 Table 2.7-1, which includes a listing of engine-driven construction equipment needed for
33 construction of a satellite ISL facility, providing insight into the magnitude of well field
34 construction activities. As a result of the limited volumes of construction waste that are
35 generated by ISL facility construction, waste management impacts from construction would
36 be SMALL.
37

38 **4.4.12.2 Operation Impacts to Waste Management**
39

40 Operations waste management impacts for the Nebraska-South Dakota-Wyoming Uranium
41 Milling Region are expected to be similar to the impacts discussed for the Wyoming West
42 Uranium Milling Region in Section 4.2.12.2 because the waste volumes, management practices,
43 waste management safety and environmental concerns, waste management permitting and
44 regulations, and relevant aspects of the NRC licensing are not expected to change significantly
45 (either in practice or effectiveness) with facility location from one region to another. Operational
46 waste management impacts would be SMALL, based on the required pre-operational disposal
47 agreement for byproduct material, regulatory controls including applicable permitting, license
48 conditions, and inspection practices, and typical facility design specifications and management

1 practices including waste treatment and volume reduction techniques, pond leak detection, and
2 other routine monitoring activities.

4 4.4.12.3 Aquifer Restoration Impacts to Waste Management

5
6 Waste management activities during aquifer restoration utilize the same treatment and disposal
7 options implemented for operations, therefore, impacts associated with aquifer restoration would
8 be similar to the operational impacts discussed in Section 4.4.12.2. Additional waste water
9 volume and the associated volume of water treatment wastes may be generated during aquifer
10 restoration; however, this would be offset to some degree by the reduction in production
11 capacity from the removal of a well field from production activities. While the amount of waste
12 water generated during aquifer restoration is dependent on site-specific conditions, Section
13 2.5.2 provides an illustrative estimate of water volume per pore volume and Section 2.11.5
14 provides experience regarding the number of pore volumes required for aquifer restoration in
15 past efforts). Furthermore, the NRC review of future ISL facility licensing would verify that
16 sufficient water treatment and disposal capacity (and the associated agreement for disposal of
17 byproduct material discussed in Section 4.2.12) are addressed. As a result, waste management
18 impacts from aquifer restoration would be SMALL.

20 4.4.12.4 Decommissioning Impacts to Waste Management

21
22 Decommissioning waste management impacts for the Nebraska-South Dakota-Wyoming
23 Uranium Milling Region are expected to be similar to the impacts discussed for the Wyoming
24 West Uranium Milling Region in Section 4.2.12.4 because the waste volumes and management
25 practices, waste management safety and environmental concerns, waste management
26 regulations, and relevant aspects of the NRC licensing are not expected to change significantly
27 (either in practice or effectiveness) with facility location from one region to another. The
28 required pre-operational agreement for disposal of byproduct material, NRC review, and
29 approval of a decommissioning plan and radiation safety program, and the small volume of solid
30 waste generated for offsite disposal suggest the waste management impacts would be SMALL.
31 Related transportation impacts are discussed separately in Section 4.4.2.

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- 8

1 **4.5 Northwestern New Mexico Uranium Milling Region**

2
3 **4.5.1 Land Use Impacts**

4
5 Information on ISL facility size (Section 2.11) and the type of potential impacts to land use
6 previously described for the two Wyoming and the Nebraska-South Dakota-Wyoming Uranium
7 Milling Regions would also generally apply for ISL facilities in the Northwestern New Mexico
8 Uranium Milling Region. For example, the total amount of land estimated to be impacted and
9 disturbed by surface facilities and well fields at the proposed commercial-scale ISL facility at
10 Crownpoint, New Mexico was between 100 and 600 ha [247 and 1,483 acres] (NRC, 1997).
11 These estimates fall within the range previously presented in Section 4.2.1 for the Wyoming
12 West Uranium Milling Region.

13
14 **4.5.1.1 Construction Impacts to Land Use**

15
16 The types of land use in this region are similar in many respects to land uses in the Wyoming
17 and Nebraska-South Dakota-Wyoming regions. Therefore, the types of construction impacts to
18 land use from new ISL facilities in the region would also be similar. New construction activities
19 would potentially: (1) change and disturb the land uses, (2) restrict access and establish right-of-
20 way for access, (3) affect mineral rights, and land use by allottees and others, (4) restrict
21 livestock grazing areas and revoke grazing permits, (5) restrict recreational activities, and
22 (6) alter ecological, cultural and historical resources.

23
24 Because of the complicated land use in the checkerboard region near tribal lands in the
25 Northwestern New Mexico Uranium Milling Region, new ISL facilities could directly abut private
26 land, allottees, and residences. Additional land use impacts could include denial of access to
27 private land being leased for ISL operations and conflicts with other land uses that would need
28 to be resolved with individual land owners and allottees. Such impacts, as is the case with most
29 land use impacts due to construction and subsequent phases, would be temporary for the life of
30 the ISL facilities (NRC, 1997). In the Northwestern New Mexico Uranium Milling Region, overall
31 potential construction impacts to land use from a potential ISL facility would range from SMALL
32 to LARGE, depending on proximity to a sensitive land use.

33
34 **4.5.1.2 Operation Impacts to Land Use**

35
36 The types of land use impacts for operational activities would be expected to be similar to
37 construction impacts regarding access restrictions, primarily because the infrastructure would
38 be already in place. Additional land disturbances would not be expected during the operational
39 activities described in detail in Section 2.4. During the operational period of an ISL facility, the
40 primary changes to land use would be the movement (sequencing) of well fields from one area
41 to another within the permitted site, and is addressed as a construction impact in Section
42 4.5.1.1. Sequentially moving active operations from one well field to the next would shift
43 potential impacts. For example, a well field where uranium recovery activities have ceased
44 could be partly restored and reopened for grazing or recreation while a new well field is being
45 developed, which would have impacts similar to those described in the preceding section for the
46 construction phase. Because access restriction and land disturbance impacts would be similar
47 to, or less than, that expected for construction, the overall potential impacts to land use from
48 operational activities would be SMALL.

1 **4.5.1.3 Aquifer Restoration Impacts to Land Use**

2
3 The types of impacts to land use during aquifer restoration would be similar in nature to the
4 potential impacts of the construction and operations phases, but because the existing
5 infrastructure is used, they would be generally less frequent or intense. For example, as aquifer
6 restoration activities proceed impacts may shift from one well field area to another and allow
7 certain access rights, grazing permits and recreational activities to be restored. Overall,
8 potential aquifer restoration impacts to land use are comparable to those of the operation phase
9 and would be expected to be SMALL.

10
11 **4.5.1.4 Decommissioning Impacts to Land Use**

12
13 Potential types of decommissioning impacts to land use would be similar to the potential
14 impacts seen during the construction, operation, and aquifer restoration phases. However, the
15 frequency and intensity of certain activities disturbing the land uses would temporarily increase
16 because there would be greater use of earth- and material-moving equipment and other heavy
17 equipment. As decommissioning and reclamation proceed, the amount of disturbed land would
18 decrease. Consequently, in the Northwestern New Mexico Uranium Milling Region, overall
19 potential decommissioning impacts to land use would be greater than during the operation and
20 aquifer restoration phases, and would range from SMALL to MODERATE.

21
22 **4.5.2 Transportation Impacts**

23
24 Truck and automobile use is associated with all phases of the ISL facility lifecycle including
25 construction, operation, aquifer restoration, and decommissioning. The estimated low
26 magnitude of road transportation from all phases of the ISL lifecycle (Section 2.8), is not
27 expected to significantly affect the amount of traffic or accident rates. One possible exception to
28 this conclusion, is that commuting traffic for facility workers, in particular, during periods of peak
29 (construction) employment, would have greater impacts when traveling roads with the lowest
30 levels of current traffic. Low-trafficked roads may also be more susceptible to wear and tear
31 from increased traffic. Localized intermittent and short-term SMALL to MODERATE impacts
32 associated with noise, dust, and incidental livestock or wildlife kills are possible, depending on
33 the proximity of residences, or other regularly occupied structures, to ISL facility access roads.
34 A more detailed assessment of transportation impacts for each phase of the ISL facility lifecycle
35 follows.

36
37 **4.5.2.1 Construction Impacts to Transportation**

38
39 ISL facilities, in general, are not large-scale or time-consuming construction projects
40 (Sections 2.3 and Table 2.7-1). The magnitude of estimated construction-related transportation
41 (Section 2.8) is expected to vary depending on the size of the facility. However, when
42 compared with the regional traffic counts provided in Section 3.5.2, most roads that would be
43 used for construction transportation in the Northwestern New Mexico Uranium Milling Region
44 would not cause significant increases in daily traffic and, therefore, traffic-related impacts would
45 be SMALL. A few roads with the lowest average annual daily traffic counts would have higher
46 (MODERATE) traffic and potential infrastructure impacts, in particular, when facilities are
47 experiencing peak construction) employment. The limited duration of ISL construction activities
48 (12-18 months) suggests impacts would be of short duration. Temporary SMALL to

1 MODERATE dust, noise, and incidental livestock or wildlife kill impacts are possible on, and in
2 the vicinity of, access roads used for construction transportation.
3

4 **4.5.2.2 Operation Impacts to Transportation**

5

6 The discussion of impacts in Section 4.2.2.2 for the Wyoming West Uranium Milling Region also
7 applies to the Northwestern New Mexico Uranium Milling Region because the same types of
8 transportation activities would be conducted regardless of location, the same regulatory controls
9 and safety practices apply, the same magnitude of transportation activities would be conducted,
10 and the assessment of accident risks is generally applicable to all regions. Applicable
11 transportation conditions for the Northwestern New Mexico Uranium Milling Region are
12 discussed in Section 3.5.2. The magnitude of existing traffic conditions in the region are similar
13 to that described for Wyoming West with regard to potential impacts and therefore operational
14 traffic-related impacts would be similar (SMALL to MODERATE). The methods and
15 assumptions considered in the accident analysis in Section 4.2.2.2 (Wyoming West Uranium
16 Milling Region) for yellowcake shipments are applicable to the Northwestern New Mexico
17 Uranium Milling Region and therefore, the impact from yellowcake, resin transfer, and byproduct
18 waste shipments would be similar (SMALL). The same practices and requirements that serve to
19 limit the risks from chemical shipments also apply to the Northwestern New Mexico Uranium
20 Milling Region, and would also result in SMALL impacts.
21

22 **4.5.2.3 Aquifer Restoration Impacts to Transportation**

23

24 Aquifer restoration transportation impacts are expected to be less than described for
25 construction and operations because transportation activities would be primarily limited to
26 supplies (including chemicals for reverse osmosis), chemical waste shipments, on site
27 transportation, and employee commuting. No additional unique transportation activities are
28 expected during aquifer restoration, therefore, no additional types of impacts associated with
29 aquifer restoration are anticipated, and impacts would be SMALL to MODERATE considering
30 the potential impacts of commuting during peak employment periods on low traffic roads.
31

32 **4.5.2.4 Decommissioning Impacts to Transportation**

33

34 Decommissioning 11e.(2) by-product wastes (as defined in the Atomic Energy Act) would be
35 shipped offsite by truck for disposal at a licensed disposal site. Section 2.8 provides estimates
36 of the number of decommissioning-related waste shipments, which are small compared to
37 average annual daily traffic counts provided in Section 3.5.2. All radioactive waste shipments
38 must be shipped in accordance with the applicable NRC safety requirements in 10 CFR Part 71.
39 As shown in Section 2.8, the number of estimated decommissioning waste shipments is fewer
40 than those needed to support facility operations and therefore, potential traffic and accident
41 impacts are expected to decrease during the decommissioning period. Risks from transporting
42 yellowcake shipments during operations bound the risks expected from waste shipments owing
43 to the concentrated nature of shipped yellowcake, the longer distance yellowcake is shipped
44 relative to waste destined for a licensed disposal facility, and the relative number of shipments
45 for each type of material. Commuting impacts would decrease from peak employment due to
46 cessation of operations, though, this effect would be offset to some degree by an increase in
47 decommissioning workers. Overall, based on the magnitude of transportation activities
48 expected during decommissioning, impacts would be SMALL.
49

1 **4.5.3 Geology and Soils Impacts**
2

3 Construction, operation, aquifer restoration, and decommissioning activities and processes at
4 ISL facilities may impact geology and soils. The potential impacts on geology and soils from
5 these activities in the Northwestern New Mexico Uranium Milling Region are discussed in the
6 following sections.
7

8 **4.5.3.1 Construction Impacts to Geology and Soils**
9

10 During construction of ISL facilities, the principal impacts to geology and soils would result
11 from earth-moving activities associated with constructing surface facilities, wastewater
12 evaporation ponds, access roads, well fields, and pipelines (Section 2.3). Earth-moving
13 activities would include:
14

- 15 • Clearing of ground or top soil and preparing surfaces for the processing plant, satellite
16 facilities, pump houses, access roads, drilling sites, and associated structures
17
- 18 • Excavating and backfilling trenches for pipelines and cables
19
- 20 • Excavating evaporation ponds and developing evaporation pond embankments
21

22 The impact of construction activities on geology and soils will depend on local topography,
23 surface bedrock geology, and soil characteristics. Generally, earth-moving activities will result
24 in only SMALL (approximately 10 percent of the permitted site) and temporary (several months)
25 disturbance of soils—impacts that are commonly mitigated using accepted best management
26 practices (see Section 7). For example, soil horizons will be disrupted to construct the
27 processing facilities, evaporation ponds, and well field houses. In the well field, soil disturbance
28 would be limited to drill pad grading, mud pit excavation, well completion, and access road
29 construction.
30

31 Construction activities at ISL facilities in the Northwestern New Mexico Uranium Milling Region
32 would increase the potential for erosion from both wind and water due to the removal of
33 vegetation and the physical disturbance from vehicle and heavy equipment traffic. Operators of
34 ISL facilities typically adopt construction practices that prevent or substantially reduce erosion.
35 Soils removed during construction of surface facilities are generally stockpiled and stabilized for
36 later use during decommissioning and land reclamation. These stockpiles would be specifically
37 located, shaped, and seeded with a cover crop by the operator to control erosion. For example,
38 during the construction of the proposed Crownpoint ISL facility, areas where topsoil was
39 temporarily removed would be replaced and re-vegetated once construction was completed
40 (NRC, 1997).
41

42 As part of the underground infrastructure at ISL facilities, a network of buried process pipelines
43 and cables is typically constructed. Pipeline systems are installed between the pump house
44 and well field for injecting and recovering lixiviant, between the pump house and the satellite
45 facility or processing plant for transporting lixiviant and resin, and between the processing
46 facilities and deep injection wells. Trenches for the pipelines are excavated as deep as 6 feet
47 below the ground to avoid any potential freezing problem. Excavating trenches for pipelines
48 and cables normally results in only a SMALL, short-term disturbance of rock and soil. After

1 piping and cable are placed in the trenches they are backfilled with the excavated material and
2 graded to surrounding ground topography.

3
4 Based on the above discussion, the impacts of construction activities on geology and soils at
5 ISL facilities in the Northwestern New Mexico Uranium Milling Region would be SMALL.

6 7 **4.5.3.2 Operation Impacts to Geology and Soils**

8
9 During ISL operations (Section 2.4), a non-uranium-bearing (barren) solution or lixiviant is
10 injected through wells into the mineralized zone. The lixiviant moves through the pores in the
11 host rock, dissolving uranium and other metals. Production wells withdraw the resulting
12 "pregnant" lixiviant, which contains uranium and other dissolved metals, and pump it to a central
13 processing plant or to a satellite processing facility for further uranium recovery and purification.

14
15 The removal of uranium from the target sandstones during ISL operations would result in a
16 permanent change to the composition of uranium-bearing rock formations. However, the
17 uranium mobilization and recovery process in the target sandstones does not result in the
18 removal of rock matrix or structure. The source formations for uranium in the Northwestern New
19 Mexico Uranium Milling Region occur at depths of hundreds of feet below the ground surface.
20 For example, the top of the uranium-bearing sandstone (Westwater Canyon Member of the
21 Morrison Formation) at the Crownpoint and Church Rock sites near Crownpoint, New Mexico
22 are at depths of 560 m [1,840 ft] and 140 to 230 m [460 to 760 ft], respectively (NRC, 1997).
23 However, ground subsidence at conventional underground mine workings has been cited as a
24 potential issue (NRC, 1997).

25
26 The pressure of the producing aquifer is decreased during operation activities because a
27 negative water balance is maintained in the well field to ensure water flows into the well field
28 from its edges, reducing the spread of contamination. This change in pressure theoretically
29 could impact the transmissivity (e.g., resistance to flow) of faults in permitted areas. However,
30 this change in pressure is not expected to be significant enough to reactivate local faults and it
31 is expected to be extremely unlikely that any earthquakes would be generated. Based on
32 historical ISL operations in the Northwestern New Mexico Uranium Milling Region, reactivation
33 of faults has not been observed.

34
35 A potential impact to soils arises from the necessity to move barren and pregnant uranium-
36 bearing lixiviant to and from the processing facility in aboveground and underground pipelines.
37 If a pipe ruptures or fails, lixiviant can be released and (1) pond on the surface, (2) run off into
38 surface water bodies, (3) infiltrate and adsorb in overlying soil and rock, or (4) infiltrate and
39 percolate to groundwater.

40
41 In the case of spills from pipeline leaks and ruptures, spills could release either radionuclides or
42 other constituents (e.g., selenium or other metals). Any impacts of these two types of spills are
43 likely to be bounded by a spill of pregnant lixiviant (Mackin, et al., 2001). If the spill is allowed to
44 dry, it can pose an ingestion or inhalation hazard to both humans and wildlife. Licensees are
45 expected to establish immediate spill responses through onsite standard operation procedures
46 (e.g., NRC 2003, Section 5.7). For example, immediate spill responses might include shutting
47 down the affected pipeline, recovering as much of the spilled fluid as possible, and collecting
48 samples of the affected soils for comparison to background values for uranium, radium, and
49 other metals.

1 As part of the monitoring requirements at ISL facilities, licensees must report certain spills to the
2 NRC within 24 hours. These spills include those that cause unplanned contamination that
3 meets the criteria of 10 CFR 40.60 and those spills that could cause exposures that exceed the
4 limits established in 10 CFR 20 Subpart M. Additional reporting requirements may be imposed
5 by the state or by NRC license conditions. For example, NRC license conditions may require
6 that licensees report spills to the NRC project manager and subsequently submit a written report
7 describing the conditions leading to the spill, the corrective actions taken, and the results
8 achieved (NRC, 2003). This documentation helps in final site decommissioning activities.
9 Licensees of ISL facilities in the Northwestern New Mexico Uranium Milling Region must also
10 comply with any applicable state permitting agency requirements for spill response and
11 reporting.

12
13 Soil contamination during ISL operations could also occur from transportation accidents
14 resulting in yellowcake or ion exchange resin spills. As for lixiviant spills, licensees must report
15 certain of these spills to NRC and the appropriate state permitting agency. License conditions
16 also may require licensees to report the corrective actions taken and the results achieved. For
17 non-radiological chemicals stored at the processing facility, spill responses would be similar to
18 those described for yellowcake transportation, although the spill of non-radiological materials is
19 primarily reportable to the appropriate state agency or EPA.

20
21 In the short term, impacts to soils from spills could range from SMALL to LARGE depending on
22 the volume of soil affected by the spill. Because of the required immediate responses, spill
23 recovery actions, and routine monitoring programs, impacts from spills are temporary, and the
24 overall long-term impact to soils is SMALL.

25
26 Uranium mobilization and processing during ISL operations produces excess water containing
27 lixiviants and minerals leached from the aquifer. Other liquid waste streams produced by ISL
28 operations can include rejected brine from the reverse osmosis system and spent eluant from
29 the ion exchange system. Any of these waste streams may be discharged to evaporation ponds
30 or injected into deep waste disposal wells. In addition, wastewater may be treated and applied
31 to the land using irrigation methods or discharged to surface water drainages. The impacts and
32 requirements for discharging treated waste streams to surface water bodies during ISL
33 operations in the Northwestern New Mexico Uranium Milling Region are discussed in Section
34 4.5.4.1. The impacts of using evaporation ponds or applying treated wastewater to the land are
35 discussed in this section.

36
37 Although waste streams are treated before discharge to evaporation ponds, they may still
38 contain radionuclides and other metals that may become concentrated during evaporation.
39 Therefore, soil contamination could result if either the liner or embankment of an evaporation
40 pond was to fail. Evaporation ponds at NRC-licensed ISL facilities are designed with leak
41 detection systems to detect liner failures. The licensee is also required to maintain sufficient
42 reserve capacity in the evaporation pond system to enable transferring the contents of a pond to
43 other ponds in the event of a leak and subsequent corrective action and liner repair. To
44 minimize the likelihood of failure, pond embankments at ISL facilities are monitored and
45 inspected by licensees in accordance with NRC-approved inspection programs, and NRC
46 currently inspects the embankments regularly as part of the federal Dam Safety program.

47
48 Land application of treated wastewater involves irrigating select parcels of land and allowing the
49 water to be evapotranspired by native vegetation or crops (Sections 2.7.2, 4.2.12.2). Land
50 application of treated wastewater could potentially impact soils. For example, the salinity of the

1 treated waste water could increase the salinity of soils (soil salination) and reduce the
2 permeability of soils in the irrigation area. At the proposed ISL site near Crownpoint,
3 New Mexico, the soil electrical conductivity of areas irrigated with treated wastewater would be
4 monitored to mitigate the effects of soil salination.
5

6 Land application of the treated wastewater would also cause radiological and/or other
7 constituents (e.g., selenium and other metals) to accumulate in the soils. At NRC-licensed ISL
8 facilities, the licensee is required to monitor and control irrigation areas, if used, to maintain
9 levels of radioactive and toxic constituents within allowable release standards. In addition,
10 states, which typically regulate land application of wastewater, may impose release limits on
11 non-radiological constituents. The licensee uses its environmental monitoring program (see
12 Chapter 8) to identify soil impacts caused by land application of treated process water.
13 Monitoring would include analyzing water before it is applied to land to make sure release
14 limits are met and soil sampling to ensure that concentrations of uranium, radium, and other
15 metals are within allowable limits. Areas of a site where land application of treated water has
16 been used would also be included in decommissioning surveys to ensure soil concentration
17 limits are not exceeded. Because of the routine nature of the monitoring program and inclusion
18 of land application areas in decommissioning surveys, the impacts to soil from land application
19 of treated wastewater would be SMALL.
20

21 **4.5.3.3 Aquifer Restoration Impacts to Geology and Soils**

22

23 Aquifer restoration programs typically use a combination of: (1) groundwater transfer, (2)
24 groundwater sweep, (3) reverse osmosis, permeate injection, and recirculation, (4) stabilization,
25 and (5) water treatment and surface conveyance (Section 2.5).
26

27 The groundwater sweep and recirculation process does not result in the removal of rock matrix
28 or structure and, therefore, no significant matrix compression or ground subsidence is expected.
29 The water pressure in the aquifer is decreased during restoration because a negative water
30 balance is maintained in the well field being restored to ensure that water flows into the well field
31 from its edges, reducing the spread of contamination. However, the change in pressure is
32 limited by recirculation of treated groundwater and, therefore, it is unlikely that ISL operations
33 would reactivate local faults and extremely unlikely that any earthquakes would be generated.
34 Therefore, the impacts to geology in the Northwestern New Mexico Uranium Milling Region from
35 aquifer restoration are expected to be SMALL.
36

37 The main impact on soils during aquifer restoration would be spills of contaminated groundwater
38 resulting from pipeline leaks and ruptures. As with spills of lixiviant during operations, spill
39 response recommendations during aquifer restoration activities have been carried forward into
40 NRC guidance of ISL facilities (e.g., NRC, 2003, Section 5.7). Licensees must report certain
41 spills to NRC within 24 hours. These spills include those that cause unplanned contamination
42 that meets the criteria of 10 CFR 40.60 and those spills that could cause exposures that exceed
43 the limits established in 10 CFR 20 Subpart M. Additional reporting requirements may be
44 imposed by the state or by NRC license conditions. For example, NRC license conditions may
45 require that licensees report spills to the NRC project manager and subsequently submit a
46 written report describing the conditions leading to the spill, the corrective actions taken, and the
47 results achieved (NRC, 2003). Licensees in the Northwestern New Mexico Uranium Milling
48 Region are also required to comply with any applicable state permitting agency requirements for
49 spill response and reporting. The short term impact on soils from spills of contaminated
50 groundwater could range from SMALL to LARGE depending on the volume the affected soil.

1 Because of the required immediate responses, spill recovery actions, and routine monitoring
2 programs, impacts from spills are temporary, and the overall long-term impact to soils is
3 SMALL.

4
5 During aquifer restoration the groundwater is passed through semipermeable membranes that
6 yield a brine or reject liquid. This reject liquid cannot be injected back into the aquifer or
7 discharged directly to the environment. The reject liquid is typically sent to an evaporation pond
8 or to deep well disposal. In addition, treated wastewater may be applied to the land.

9
10 If reject water is sent to an evaporation pond, failure of the evaporation pond liner or pond
11 embankment could result in soil contamination. Evaporation ponds at NRC licensed ISL
12 facilities are designed with leak detection systems to detect liner failures, and are visually
13 inspected on a regular basis. The licensee is also required to maintain sufficient reserve
14 capacity in the evaporation pond system to enable transferring the contents of a pond to other
15 ponds in the event of a leak and subsequent corrective action and liner repair. To minimize the
16 likelihood of pond embankment failures, NRC requires licensees to monitor and inspect pond
17 embankments at ISL facilities in accordance with NRC-approved inspection programs. NRC
18 currently inspects the embankments regularly as part of the federal Dam Safety program.

19
20 As with ISL operations, land application of treated waste water during aquifer restoration could
21 potentially impact soils (Sections 2.7.2, 4.2.12.2). For example, the salinity of the treated waste
22 water could increase the salinity of soils (soil salination) and reduce the permeability of soils in
23 the irrigation area. Land application of the treated wastewater could also cause radiological
24 and/or other constituents to accumulate in the soils. At NRC-licensed ISL facilities, the licensee
25 is required to monitor and control irrigation areas, if used, to maintain levels of radioactive
26 constituents within allowable release standards. In addition, states, which typically regulate land
27 application of wastewater, may impose release limits on non-radiological constituents. The
28 licensee uses its environmental monitoring program (see Chapter 8) to identify soil impacts
29 caused by land application of treated process water. Monitoring includes analyzing water
30 before it is applied to land to make sure release limits are met and soil sampling to ensure that
31 concentrations of uranium, radium, and other metals are within allowable standards. Areas of a
32 site where land application of treated water has been used are also included in
33 decommissioning surveys to ensure soil concentration limits are not exceeded. Because of the
34 routine monitoring program and inclusion of land application areas in decommissioning surveys,
35 the impacts to soil from land application of treated wastewater would be SMALL.

36 37 **4.5.3.4 Decommissioning Impacts to Geology and Soils**

38
39 Decommissioning of ISL facilities includes: (1) dismantling process facilities and associated
40 structures, (2) removing buried piping, and (3) plugging and abandoning wells using accepted
41 practices. The main impacts to geology and soils in the Northwestern New Mexico Uranium
42 Milling Region during decommissioning would be from activities associated with land
43 reclamation and cleanup of contaminated soils. These activities are described in Section 2.6.

44
45 Before decommissioning and reclamation activities begin, the licensee is required to submit a
46 decommissioning plan to NRC for review and approval. The licensee's spill documentation—an
47 NRC requirement—would be used to identify potentially contaminated soils requiring offsite
48 disposal at a licensed facility. Any areas potentially impacted by operations would be included
49 in surveys to ensure all areas of elevated soil concentrations are identified and properly
50 cleaned up to comply with NRC regulations at 10 CFR Part 40, Appendix A, Criterion 6-(6).

1
2 Most of the impacts to geology and soils associated with decommissioning are temporary and
3 SMALL. Because the goal of decommissioning and reclamation is to restore the facility to
4 preproduction conditions to the extent practical, the overall long-term impacts to the geology
5 and soils would be SMALL.
6

7 **4.5.4 Water Resources Impacts**

8 9 **4.5.4.1 Surface Water Impacts**

10 11 **4.5.4.1.1 Construction Impacts to Surface Water**

12
13 Potential impacts to Waters of the U.S. are regulated by permit under Section 404 of the Clean
14 Water Act (Appendix B). The use of these permits also requires that the actions satisfy the
15 individual state Section 401 certification with regard to water quality. In New Mexico the Surface
16 Water Quality Bureau of the New Mexico Environment Department has issued condition
17 Section 401 Certification for discharges into ephemeral streams. In addition the Surface Water
18 Quality Bureau requires that a project-specific Section 401 Water Quality Certification must be
19 obtained [see 33 CFR 330.4(c)] for discharges to any intermittent, perennial, and wetland
20 surface waters and to any Outstanding National Resource Waters prior to construction. The
21 Surface Water Quality Bureau requires a complete application and USACE permit verification
22 prior to commencing the water quality certification review (New Mexico Surface Water Quality
23 Bureau, 2007). If the project does not meet the requirements for a nationwide permit, then an
24 individual Section 404 permit will be required.
25

26 Storm water runoff during construction would be controlled through a Storm Water Pollution
27 Prevention Plan that is part of a NPDES permit issued by EPA (Section 1.7.2.1). Because
28 average annual runoff in the Northwestern New Mexico Uranium Milling Region is less than in
29 the Wyoming West Uranium Milling Region (U.S. Geological Survey, 2008), where the
30 construction impact to surface waters would be SMALL, the potential for surface water impacts
31 in this region would also be SMALL.
32

33 **4.5.4.1.2 Operation Impacts to Surface Water**

34
35 The potential causes and nature of surface water impacts for the Northwestern New Mexico
36 Uranium Milling Region are expected to be similar to those discussed for the Wyoming West
37 Uranium Milling Region (Section 4.2.4.2.2). Because of the small number of perennial streams
38 in the Northwestern New Mexico Uranium Milling Region, the potential impacts upon surface
39 waters would be SMALL. Storm water runoff and other discharges to surface water in New
40 Mexico are controlled by a Storm Water Pollution Prevention Plan and NPDES permit issued by
41 EPA rather than a state agency (Section 1.7.2.1). Compliance with the requirements for these
42 permits is expected to result in SMALL impacts to surface water from operations activities.
43

44 **4.5.4.1.3 Aquifer Restoration Impacts to Surface Water**

45
46 The potential causes and nature of surface water impacts for the Northwestern New Mexico
47 Uranium Milling Region are expected to be similar to those discussed for the Wyoming West
48 Uranium Milling Region (Section 4.2.4.2.3). Because of the small number of perennial streams
49 in the Northwestern New Mexico Uranium Milling Region, the potential impacts from aquifer

1 restoration would be SMALL. Storm water runoff and other discharges to surface water in New
2 Mexico are controlled by a Storm Water Pollution Prevention Plan and NPDES permit issued by
3 EPA rather than a state agency (Section 1.7.2.1). Compliance with the requirements for these
4 permits would result in SMALL impacts to surface water from aquifer restoration.
5

6 4.5.4.1.4 Decommissioning Impacts to Surface Water 7

8 The potential causes and nature of impacts for the Northwestern New Mexico Uranium Milling
9 Region are expected to be similar to impacts discussed for the Wyoming West Uranium Milling
10 Region (Section 4.2.4.2.4). Because of the small number of perennial streams in the
11 Northwestern New Mexico Uranium Milling Region, the potential impacts from decommissioning
12 are expected to be SMALL. Storm water runoff and other discharges to surface water in New
13 Mexico are authorized through a Storm Water Pollution Prevention Plan and NPDES permit
14 issued by EPA rather than a state agency (Section 1.7.2.1). Compliance with the requirements
15 for these permits would result in SMALL impacts to surface water from decommissioning.
16

17 4.5.4.2 Groundwater Impacts 18

19 Potential environmental impacts to groundwater resources in the western New Mexico Uranium
20 Milling Region can occur during all phases of the ISL facility's lifecycle. ISL activities can impact
21 aquifers at varying depths (separated by aquitards) above and below the uranium-bearing
22 aquifer, as well as adjacent surrounding aquifers in the vicinity of the uranium-bearing aquifer.
23 Surface activities that can introduce contaminants into soils are more likely to impact shallow
24 (near-surface) aquifers while ISL operations and aquifer restoration are more likely to impact the
25 deeper uranium-bearing aquifer, any aquifers above and below, and adjacent surrounding
26 aquifers.
27

28 ISL facility impacts to groundwater resources from all phases of the ISL facility lifecycle can
29 occur from surface spills and leaks, consumptive water use, horizontal and vertical excursions
30 of leaching solutions from production aquifers, degradation of water quality from changes in the
31 production aquifer's geochemistry, and waste management practices involving deep well
32 injection. Detailed discussion of the potential impacts to groundwater resources from
33 construction, operations, aquifer restoration, and decommissioning are provided in the
34 following sections.
35

36 4.5.4.2.1 Construction Impacts to Groundwater 37

38 During construction of ISL facilities, the potential for groundwater impacts is primarily from
39 consumptive groundwater use, drilling fluids and muds from well drilling, and spills of fuels and
40 lubricants from construction equipment (Section 2.3).
41

42 As discussed in Section 2.11.3, groundwater use during construction is limited to routine
43 activities such as dust suppression, mixing cements, and drilling support. The amounts of
44 groundwater used in these activities are small and would have a SMALL and temporary impact
45 to groundwater supplies. Groundwater quality of near surface aquifers during construction is
46 protected by best management practices such as implementation of a spill prevention and
47 cleanup plan to minimize soil contamination (Section 7.4). Additionally, the amount of drilling
48 fluids and muds introduced into aquifers during well construction would be limited and have a
49 SMALL impact to the water quality of those aquifers. Thus, construction impacts on

1 groundwater resources would be SMALL based on the limited nature of construction activities
2 and implementation of management practices to protect shallow groundwater.

3 4 4.5.4.2.2 Operation Impacts to Groundwater

5
6 During ISL operations, potential environmental impacts to shallow (near-surface) aquifers are
7 related to leaks of lixiviant from pipelines, wells, or header houses and to waste management
8 practices such as the use of evaporation ponds and disposal of treated wastewater by land
9 application. Potential environmental impacts to groundwater resources in the production and
10 surrounding aquifers involve consumptive water use and changes to water quality. Water
11 quality changes would result from normal operations in the production aquifer and from possible
12 horizontal and vertical lixiviant excursions beyond the production zone (Section 2.4). Disposal
13 of processing wastes by deep well injection (Section 2.7.2) during ISL operations also can
14 potentially impact groundwater resources.

15 16 4.5.4.2.2.1 Operation Impacts to Shallow (Near-Surface) Aquifers

17
18 A network of pipelines, as part of the underground infrastructure, is used during ISL operations
19 for transporting lixiviants between the pump house and the satellite or main processing facility
20 and also to connect injection and extraction wells to manifolds inside pumping header houses.
21 The failure of pipeline fittings or valves, or failures of well mechanical integrity in shallow
22 aquifers, could result in leaks and spills of pregnant and barren lixiviant (Section 2.3.1.2), which
23 could impact water quality in shallow (near surface) aquifers. The potential environmental
24 impacts of pipeline, valve, or well integrity failures could be MODERATE to LARGE, if

- 25
26 • the ground water table in shallow aquifers is close to the ground surface (i.e., small
27 travel distances from the ground surface to the shallow aquifers)
28
29 • the shallow aquifers are important aquifers for local domestic or agricultural water
30 supplies
31
32 • shallow aquifers are hydraulically connected to other locally or regionally important
33 aquifers.

34
35 The potential environmental impacts would be expected to be SMALL, if shallow aquifers have
36 poor water quality or yields not economically suitable for production and if they are
37 hydrologically separated from other locally and regionally important aquifers.

38
39 In some parts of the western New Mexico Uranium Milling region, local shallow aquifers with
40 small water yields exist and are often used for local water supplies. Hence, for some sites,
41 potential environmental impacts due to spills and leaks from pipeline, valve, or well integrity
42 failures to the shallow aquifers could be SMALL to MODERATE, depending on site-specific
43 conditions. Potential impacts would be reduced based on flow monitoring to detect pipeline
44 leaks and spills early and implementation of required spill response and cleanup procedures.
45 In addition, preventative measures such as well mechanical integrity testing (Section 2.3.1.1)
46 would limit the likelihood of well integrity failure during operations.

47
48 The use of evaporation ponds or land application to manage process water generated during
49 operations also could impact shallow aquifers. For example, failure of evaporation pond

1 embankments or liners could allow contaminants to infiltrate into shallow aquifers. Similarly,
2 land application of treated waste water could cause radiological or other constituents (e.g., Se
3 or other metals) to accumulate in soils or infiltrate into shallow aquifers. In general, the potential
4 impacts of these waste management activities are expected to be limited by NRC and state
5 requirements. For example, NRC requirements for leak detection systems, maintenance of
6 reserve pond capacity, and pond embankment inspections are expected to minimize the
7 likelihood of evaporation pond failures. Similarly, NRC and state release limits related to land
8 application of waste are expected to limit potential effects of land application of waste water on
9 shallow aquifers. Section 4.2.12.2 discusses the impacts of the use of evaporation ponds and
10 land application of treated wastewater in greater detail and characterizes the expected impacts
11 as SMALL.

12 4.5.4.2.2.2 Operation Impacts to Production and Surrounding Aquifers

13 The potential environmental impacts to groundwater supplies in the production and other
14 surrounding aquifers are related to consumptive water use and groundwater quality.

15 **Water Consumptive Use:** NRC-licensed flow rates for ISL facilities typically range from about
16 15,100 to 34,000 L/min [4,000 to 9,000 gal/min] (Section 2.1.3). Most of this water is returned to
17 the production aquifer after being stripped of uranium (see Section 2.4.1.2). The term
18 “consumptive use” refers to water that is not returned to the production aquifer. During
19 operations, consumptive use is due primarily to production bleed (typically between 1 and 3
20 percent of the total flow) and also includes other smaller losses. As described in Section
21 2.4.1.2, the purpose of the production bleed is to ensure that more groundwater is extracted
22 than re-injected. Maintaining this negative water balance helps to ensure that there is a net
23 inflow of groundwater into the well field to minimize the potential movement of lixiviant and its
24 associated contaminants out of the well field. Because the bleed water must be removed from
25 the well field to maintain a negative water balance, the bleed is disposed through the waste
26 water control program and is not re-injected into the well field.

27 Hypothetically, if a well field at an ISL facility in the Northwestern New Mexico Uranium Milling
28 Region is pumped at a constant rate of 22,700 L/min [6,000 gal/min] with 2 percent bleed, the
29 total volume of production bleed in a year of operation would be 240 million L [63 million gal
30 {190 acre-ft}]. For comparison, in 2000, approximately 3.96×10^{12} L [3.21 million acre-ft] of
31 water was used to irrigate 404,000 ha [998,000 acres] of land in New Mexico (Hutson *et al.*,
32 2004). This irrigation rate is equivalent to an annual application of approximately 9.81 million L
33 per hectare [3.22 acre-ft/acre]. Thus, the consumptive use of 240 million L [190 acre-ft] of water
34 due to production bleed in one year of operation is roughly equivalent to the water used to
35 irrigate 24 ha [59 acres] in New Mexico for one year.

36 Consumptive water use during operations could impact local water users who use water from
37 the production aquifer (outside of the exempted zone) by lowering water levels in local wells. In
38 addition, if production aquifers are not completely hydraulically isolated from aquifers above and
39 below, consumptive use may impact local users of these connected aquifers by causing a
40 lowering of water levels in those aquifers. However, effects on aquifers above and below are
41 expected to be limited in most cases by the confining layers typical of aquifers used for ISL
42 production. As discussed in Section 2.4.1.3, licensees conduct pre-operations testing to assess
43 the degree of hydraulic isolation of potential production aquifers at proposed ISL sites.

1 To assess the potential drawdown that could be caused by consumptive use during operations,
2 drawdowns were calculated for a hypothetical case in which the water withdrawn by an entire
3 ISL facility operating at 15,100 L/min [4,000 gal/min] with 2 percent bleed is assumed to be
4 withdrawn from a single well. This scenario would overestimate the drawdown caused by ISL
5 operations using water from a similar production aquifer because water withdrawal at a typical
6 ISL facility is distributed among hundreds of wells (Section 2.3.1.1) and tens to hundreds of
7 hectares [tens to thousands of acres] (Section 4.2.1). In this hypothetical case, drawdowns at
8 locations 1 m [3.3 ft], 10 m [33 ft], and 100 m [330 ft] away from a pumping well (representing the
9 well field) would be 3.5 m [11 ft], 2.8 m [9.2 ft], and 2.1 m [6.9 ft], respectively, after 10 years of
10 operation. These estimates were calculated using the Theis Equation (McWhorter and Sunada,
11 1977) with transmissivity and storage coefficient values of 240 m²/day (2,580 ft²/day) and 8×10^{-5} ,
12 respectively (chosen from the range of respective parameter values discussed in Section
13 3.5.4.3). As discussed in Section 4.3.4.2.2.2, drawdowns are found to be more sensitive to the
14 aquifer transmissivity than storage coefficient.

15
16 In the calculations above, the potential effect of natural recharge to the production aquifers on
17 groundwater levels is not considered. Consideration of natural recharge would reduce the
18 calculated drawdowns. However, neglecting natural recharge is not expected to have as much
19 of an effect as approximating the withdrawal from an entire facility with one hypothetical well.
20 As previously discussed, this approximation is expected to yield overestimates of the expected
21 drawdowns.

22
23 Near a well field, the short-term impact of consumptive use is expected to be SMALL to
24 MODERATE, depending on site-specific conditions (e.g., aquifer transmissivity). Impacts could
25 be moderate in relatively low transmissivity aquifers if there are local water users who use the
26 production aquifer (outside of the exempted zone) or if the production aquifer is not well-isolated
27 from other aquifers that are used locally. However, because localized drawdown near well
28 fields would dissipate after pumping stops, these localized effects are expected to be temporary.
29 The long-term impacts would be expected to be SMALL in most cases, depending on site-
30 specific conditions. Important site-specific conditions would include the consumptive use of the
31 proposed facility, the proximity of water users' wells to the well fields, the total volume of water
32 in the production aquifer, the natural recharge rate of the production aquifer, the transmissivity
33 and storage coefficient of the production aquifer, and the degree of isolation of the production
34 aquifer from aquifers above and below.

35
36 **Excursions and Groundwater Quality:** Groundwater quality in the production aquifer is
37 degraded as part of the ISL facility's operations (Section 2.4). The restoration of the production
38 aquifer is discussed in Section 2.5. For operations to occur, the uranium-bearing production
39 aquifer would need to be exempted as an underground source of drinking water through the
40 appropriate EPA or state-administered UIC program. When uranium recovery is complete in a
41 well field, the licensee is required to initiate aquifer restoration activities to restore the production
42 aquifer to baseline or pre-operational class-of-use conditions, if possible. IF the aquifer cannot
43 be returned to pre-operational conditions, NRC requires that the production aquifer be returned
44 to the maximum contaminant levels provided in Table 5C of 0CFR 40 Appendix A or to Alternate
45 Concentration Limits (ACL) approved by the NRC. For these reasons, potential impacts to the
46 water quality of the uranium-bearing production zone aquifer as a result of ISL operations would
47 be expected to be SMALL and temporary. The remainder of this section discusses the potential
48 for groundwater quality in the surrounding aquifers or outside of the production zone of the
49 producing aquifer to be impacted by excursions during ISL operation.

1 During normal ISL operations, inward hydraulic gradients are expected to be maintained by
2 production bleed so that groundwater flow is towards the production zone from the edges of the
3 well field. If this inward gradient is not maintained, horizontal excursions could occur and lead
4 to the spread of leaching solutions in ore-bearing aquifer beyond the mineralization zone. The
5 rate and extent of spread is largely driven by the collective effects of the aquifer transmissivity,
6 groundwater flow direction, and aquifer heterogeneity. The impact of horizontal excursions
7 could be MODERATE to LARGE if a large volume of contaminated water leaves the production
8 zone and moves downgradient within the production aquifer while the production aquifer outside
9 the mineralization zone is used for water production. To reduce the likelihood and
10 consequences of potential excursions at ISL facilities, NRC requires licensees to take
11 preventative measures prior to starting operations. For example, licensees must install a ring of
12 monitoring wells within and encircling the production zone to permit early detection of horizontal
13 excursions (Chapter 8). If excursions are detected, the monitoring well is placed on excursion
14 status and reported to the NRC. Corrective actions are taken and the well is placed on a more
15 frequent monitoring schedule until the well is found to no longer be in excursion.

16
17 The following discussion focuses on the potential for groundwater quality in the surrounding
18 aquifers to be impacted during ISL operations. The rate of vertical flow and the potential for
19 excursions between the production aquifer and an aquifer above or below is determined by
20 groundwater level (piezometric head) differences between the adjacent aquifers and the
21 thickness and vertical hydraulic conductivity of an aquitard that hydraulically separates them
22 (McWhorter and Sunada, 1977; Driscoll, 1986).

23
24 Vertical hydraulic head gradients between the production aquifer and the underlying and
25 overlying aquifers could be altered by potential increases in pumpage from the overlying or
26 underlying aquifers for water supply purposes in the vicinity of an ISL facility (e.g., from the
27 overlying Dakota Sandstone or the underlying Cow Springs Sandstone), which may enhance
28 potential vertical excursions from the production aquifer (the Morrison Formation including the
29 ore-bearing Westwater Canyon aquifer). Discontinuities in the thickness and spatial
30 heterogeneities in the vertical hydraulic conductivity of confining units could lead to vertical flow
31 and excursions.

32
33 In addition, potential well integrity failures during ISL operations could lead to vertical
34 excursions. Well casings above or below the uranium-bearing aquifer—through inadequate
35 construction, degradation, or accidental rupture—could allow lixiviant to travel from the well bore
36 into the surrounding aquifer. Moreover, deep monitoring wells drilled through the production
37 aquifer and confining units that penetrate aquitards could potentially create vertical pathways for
38 excursions of lixiviant from the production aquifers to the adjacent aquifers.

39
40 Some relevant factors when considering the significance of potential impacts from a vertical
41 excursion (such as local geology and hydrology and the proximity of injection wells to drinking
42 water supply wells) are discussed in Section 2.4.1. Additionally, past experience with
43 excursions reported at NRC-licensed ISL facilities are discussed in Section 2.11.5.

44
45 To reduce the likelihood and consequences of potential excursions at ISL facilities, NRC
46 requires licensees to take preventive measures prior to starting operations. For example,
47 licensees must conduct MIT to ensure that lixiviant would remain in the well and not escape into
48 surrounding aquifers (Section 2.3.1). Licensees are required to conduct aquifer pump tests
49 prior to starting operations in a well field. The purpose of these pump tests is to determine
50 aquifer parameters (e.g., aquifer transmissivity and storage coefficient, and the vertical hydraulic

1 conductivity of aquitards) and also to ensure that confining layers above and below the
2 production zone are expected to preclude the vertical movement of fluid from the production
3 zone into the overlying and underlying units). The licensee must also develop and maintain
4 monitoring programs to detect both vertical and horizontal excursions and must have operating
5 procedures to analyze an excursion and determine remediation actions. The monitoring
6 programs prescribe the number, depth, and location of monitoring wells, sampling intervals,
7 sampling water quality parameters, and the UCLs for particular water quality parameters
8 (Chapter 8). These specifications typically are made conditions in the NRC license.
9

10 If excursions are observed at the monitoring wells, the licensee would increase sampling and
11 commence corrective actions. The excursions typically would be reversed by increasing the
12 overproduction rate and drawing the lixiviant back into the extraction zone.
13

14 Monitoring wells typically are completed in the lower portion of the first aquifer above the ore-
15 bearing aquifer and in the upper portion of the first aquifer below the ore-bearing aquifer. As
16 described in Section 3.5.4.3.2, the Dakota Sandstone overlies the ore-bearing aquifer and the
17 Cow Springs Sandstone underlies the ore-bearing aquifer in the vicinity of the existing ISL sites.
18

19 In general, the potential environmental impacts of vertical excursions to groundwater quality in
20 surrounding aquifers would be SMALL, if the vertical hydraulic head gradients between the
21 production aquifer and the adjacent aquifer are small, the vertical hydraulic conductivity of the
22 confining units is low, and the confining layers are sufficiently thick. On the other hand, the
23 environmental impacts could be MODERATE to LARGE, if confinements are discontinuous,
24 thin, or fractured (i.e., high vertical hydraulic conductivities. To limit the likelihood of vertical
25 excursions, licensees conduct mechanical integrity testing of the injection and production wells
26 to ensure that lixiviant remains in the well and not escape into surrounding aquifers (Section
27 2.3.1). Licensees also must conduct pre-operational pump tests to ensure adequate
28 confinement of the production zone. In addition, licensees must develop and maintain programs
29 to monitor above and below the ore-bearing zone to detect both vertical and horizontal
30 excursions and flow rates, and must have operating procedures to analyze an excursion and
31 determine remediation actions.
32

33 In Northwestern New Mexico Uranium Milling region, the ore-bearing aquifer (the Westwater
34 Canyon aquifer in the Morrison Formation) is confined below and above by continuous and thick
35 confining layers at the ISL sites. The thickness of the aquitards is reportedly variable in the
36 milling region (NRC, 1997). There is no evidence on the fracture nature of these confining
37 layers in the region. If the licensee installs and maintains the monitoring well network properly,
38 potential impacts of vertical excursions would be temporary and the long-term effects would be
39 SMALL.
40

41 4.5.4.2.2.3 Operation Impacts to Deep Aquifers Below the Production Aquifers 42

43 Potential environmental impacts to confined deep aquifers below the production aquifers could
44 be due to deep well injection of processing wastes into deep aquifers. Under different
45 environmental laws such as the Clean Water Act, the Safe Drinking Water Act, and the Clean
46 Air Act, EPA has statutory authority to regulate activities that may affect the environment.
47 Underground injection of fluid requires a permit from the EPA (Section 1.7.2).
48

49 At the proposed ISL facility site in Crownpoint, New Mexico, the Cow Springs aquifer and
50 Entrada sandstone do not appear to be potential aquifers for deep injection because data

1 indicate that the Cow Springs Sandstone contains good quality water (Hydro Resources, Inc.,
2 1996; NRC, 1997) and this aquifer is not hydraulically separated from the underlying Entrada
3 Sandstone. Thus, no deep aquifer has been identified in that portion of the uranium milling
4 region for deep injection of leaching solutions.
5

6 The potential environmental impacts of injection of leaching solutions into deep aquifers below
7 ore-bearing aquifers would be expected to be SMALL, if water production from deep aquifers is
8 not economically feasible or the groundwater quality from these aquifers is not suitable for
9 domestic or agricultural uses (e.g., high salinity), and they are confined above by sufficiently
10 thick low permeability layers. As discussed previously, licensees seeking to dispose of liquid
11 effluents by deep well injection would need to be granted a permit to do so from the EPA or
12 appropriate State agency.
13

14 4.5.4.2.3 Aquifer Restoration Impacts to Groundwater

15
16 The potential environmental impacts to groundwater resources during aquifer restoration are
17 related to groundwater consumptive use and waste management practices, including discharge
18 of wastes to evaporation ponds, land application of treated wastewater, and potential deep
19 disposal of brine slurries resulting from reverse osmosis. In addition, aquifer restoration directly
20 affects groundwater quality in the vicinity of the wellfield being restored.
21

22 Aquifer restoration typically involves a combination of the following methods: (1) groundwater
23 transfer, (2) groundwater sweep, (3) reverse osmosis with permeate injection, and (4)
24 groundwater recirculation. These methods are discussed in depth in Section 2.5. In addition to
25 these processes, potential new restoration processes are being developed. These processes
26 include the use of controlled biological reactions to precipitate uranium and other contaminants
27 by restoring chemically reducing conditions to production aquifers. However, these processes
28 have not yet been used at a commercial scale, and their likely impacts will not be known until
29 the processes have been developed further.
30

31 Groundwater consumptive use for groundwater transfer would be minimal, because milling-
32 affected water in the restoration well field is displaced with baseline quality water from outside
33 the well field. Groundwater consumptive use would be large for groundwater sweep, because it
34 involves pumping groundwater from well field without injection. The rate of groundwater
35 consumptive use would be lower during the reverse osmosis phase, because up to 70 percent
36 of the pumped groundwater treated with reverse osmosis can be re-injected into the aquifer.
37 Groundwater consumptive use could be further decreased during the reverse osmosis phase if
38 brine concentration is used, in which case up to 99 percent of the withdrawn water could be
39 suitable for re-injection. In that case, the actual amount of water that is re-injected into the well
40 field may be limited by the need to maintain a negative water balance to achieve the desired for
41 of water from outside the well field into the well field.
42

43 Groundwater consumptive use during aquifer restoration is generally reported to be greater than
44 during ISL operations (Freeman and Stover, 1999; NRC, 2003; Chapter 2 of this GEIS). One
45 reason for increased consumptive use during restoration is that, as previously discussed, no
46 water is re-injected during groundwater sweep. Water is not re-injected during groundwater
47 sweep because the purpose of the sweep phase is to remove contaminated water from a well
48 field and draw unaffected water into the well field. For example, at the Irigaray Mine in
49 Campbell County, Wyoming, between 1.4 and 4.2 pore volumes of water were removed from six
50 restoration units (comprising nine well fields, some of which were combined for restoration).

1 The total volume of water consumed to perform groundwater sweep on all of the wellfields was
2 545 million L [144 million gal].
3

4 As discussed in Section 2.5, restoration typically is performed as well fields end production, so
5 all of the well fields do not undergo groundwater sweep at the same time. For example, at the
6 Irigaray Mine, (COGEMA Mining, Inc., 2004), average pumping rates for groundwater sweep
7 ranged from approximately 100 L/min [27 gal/min] to pump 120 million L [31 million gal] from
8 two well fields between June 1991 and August 1993 to 380 L/min [100 gal/min] to pump 190
9 million L [49 million gal] from three well fields between May of 1990 and April of 1991. At the
10 Smith Ranch/Highland Uranium Project in Converse County, Wyoming, an average pumping
11 rate of approximately 38 L/min [10 gal/min] was used to pump 3.2 pore volumes (49 million L
12 [13 million gal]) from the A-Wellfield during almost 3 years groundwater sweep (Power
13 Resources, Inc., 2004).
14

15 The actual rate of groundwater consumption at an ISL facility at any time depends, in part, on
16 the various stages of operation and restoration of the individual well fields at the facility. For
17 example, consider a hypothetical case in which three well fields at a site undergo groundwater
18 sweep while three undergo reverse osmosis treatment with permeate re-injection and another
19 three continue production. Hypothetically, while 380 L/min [100 gal/min] are consumed during
20 groundwater sweep of three well fields, 110 L/min [30 gal/min] may be consumed to perform
21 reverse osmosis treatment in another three wellfields, and another 38 L/min [10 gal/min] may be
22 consumed by production bleed in the remaining three well fields. The total water consumption
23 rate while these processes continued would be 530 L/min [140 gal/min].
24

25 At a rate of 530 L/min [140 gal/min], 280 million L [74 million gal] would be consumed in one
26 year. For comparison, in 2000, approximately 3.96×10^{12} L [3.21 million acre-ft] of water was
27 used to irrigate 404,000 ha [998,000 acres] of land in New Mexico (Hutson *et al.*, 2004). This
28 irrigation rate is equivalent to an annual application of approximately 9.81 million L per hectare
29 [3.22 acre-ft/acre]. Thus, consumption of 280 million L [74 million gal or 230 acre-ft] in one year
30 of restoration would be roughly equivalent to the water used to irrigate 29 ha [72 acres] in New
31 Mexico for one year.
32

33 Potential environmental impacts are affected by the restoration techniques chosen, the severity
34 and extent of the contamination, and the current and future use of the production and
35 surrounding aquifers in the vicinity of the ISL facility or at the regional scale. The potential
36 environmental impacts of groundwater consumptive use during restoration could be SMALL to
37 MODERATE. Site-specific impacts also would depend on the proximity of water users' wells to
38 the well fields, the total volume of water in the aquifer, the natural recharge rate of the
39 production aquifer, the transmissivity and storage coefficient of the production aquifer, and the
40 degree of isolation of the production aquifer from aquifers above and below.
41

42 During aquifer restoration, the most heavily contaminated groundwater may be disposed
43 through the wastewater treatment system. The impacts of discharging wastes to solar
44 evaporation ponds or applying treated wastewater to land during restoration are expected to be
45 similar to the impacts of these waste management practices during operations (SMALL)
46 (Section 4.5.4.2.2.1).
47

48 As discussed in Section 4.2.4.2.2.3, underground injection of fluid requires a permit from EPA or
49 authorized State and approval from the NRC. Additionally, the briny slurry produced during
50 reverse osmosis process may be pumped to a deep well for disposal (Section 2.7.2). The deep

1 aquifers suitable for injections must have poor water quality, low water yields, or be
2 economically infeasible for production. They also need to be hydraulically separated from
3 overlying aquifer systems. Under these conditions, the potential environmental impacts would
4 be SMALL.
5

6 Aquifer restoration processes also affect groundwater quality directly by removing contaminated
7 groundwater from wellfields, re-injecting treated water, and re-circulating groundwater. In
8 general, aquifer restoration is continued until NRC and applicable state requirements for
9 groundwater quality are met. As discussed in Section 4.3.4.2.2.2, NRC licensees are required
10 to restore the production aquifer to baseline or pre-operational class-of-use conditions, if
11 possible. If the aquifer cannot be returned to pre-operational conditions, NRC requires that the
12 production aquifer be returned to the maximum contaminant levels provided in Table 5C of 10
13 CFR 40 Appendix A or to Alternate Concentration Limits (ACL) approved by the NRC. Historical
14 information about aquifer restoration at several NRC-licensed facilities is discussed in Section
15 2.11.5.
16

17 4.5.4.2.4 Decommissioning Impacts to Groundwater

18
19 The environmental impacts to groundwater during dismantling and decommissioning ISL
20 facilities are primarily associated with consumptive use of groundwater, potential spills of fuels
21 and lubricants, and well abandonment. The consumptive groundwater use could include water
22 use for dust suppression, re-vegetation, and reclaiming disturbed areas (Section 2.6). The
23 potential environmental impacts during the decommissioning phase are expected to be similar
24 to potential impacts during the construction phase. Groundwater consumptive use during the
25 decommissioning activities would be less than groundwater consumptive use during ISL
26 operation and groundwater restoration activities. Spills of fuels and lubricants during
27 decommissioning activities could impact shallow aquifers. Implementation of best management
28 practices (Chapter 7) during decommissioning can help to reduce the likelihood and magnitude
29 of such spills. Based on consideration of best management practices to minimize water use and
30 spills, impacts to the groundwater resources in shallow aquifers from decommissioning would
31 be expected to be SMALL.
32

33 After ISL operations are completed, improperly abandoned wells could impact aquifers above
34 the production aquifer by providing hydrologic connections between aquifers. As part of the
35 restoration and reclamation activities, all monitors, injection, and recovery wells will be plugged
36 and abandoned. The wells will be filled with cement and clay and then cut off below plough
37 depth to ensure that no groundwater flows through the abandoned wells (Stout and Stover,
38 1997). If this process is properly implemented and the abandoned wells are properly isolated
39 from the flow domain, the potential environmental impacts would be SMALL.
40

41 4.5.5 Ecological Resources Impacts

42 43 4.5.5.1 Construction Impacts to Ecological Resources

44 45 Vegetation

46
47 ISL uranium recovery facility construction primarily affects terrestrial vegetation through: (1) the
48 removal of vegetation from the milling site during construction (and associated reduction in
49 wildlife habitat and forage productivity and an increased risk of soil erosion and weed invasion);

1 (2) the modification of existing vegetative communities as a result of milling maintenance;
2 (3) the loss of sensitive plants and habitats as a result of construction clearing and grading; and
3 (4) the potential spread of invasive species and noxious weed populations as a result
4 of construction.

5
6 ISL facilities typically are located on large tracts of land in remote areas. Permit areas of past
7 facilities have ranges from 69 ha [170 ac] to 6,480 ha [16,000 ac] (Section 2.10.1). Typically,
8 the amount of land disturbance within these permitted areas range from 49 ha to 485 ha [120 ac
9 to 1,200 ac]. The percent of vegetation removed (disturbed land) ranges from a low of
10 1 percent to as much as 20 percent, but is typically less than 10 percent. This results in a
11 relatively SMALL impact in relation to the total permit area and surrounding plant communities.

12
13 Clearing herbaceous vegetation during construction in an open grassland or shrub steppe
14 community is anticipated to have a short-term impact. If active re-vegetation measures are
15 used with seed mixtures approved by the New Mexico Environmental Department, colonization
16 by annual and perennial herbaceous species in the disturbed staging areas and right-of-way
17 would restore most vegetative cover within the first growing season, and impacts from clearing
18 would be SMALL.

19
20 Clearing woody shrubs and trees would have a longer-term impact than herbaceous clearing.
21 While woody shrubs and trees would re-colonize the temporary construction right-of-way and
22 staging areas, they would re-colonize more slowly than would herbaceous species. As natural
23 succession is allowed to proceed in these areas, the early successional or forested communities
24 that existed before construction would eventually be reestablished. Clearing trees in the milling
25 site could affect forest vegetation growing along the edges of the cleared areas. Exposing
26 some edge trees to elevated levels of sunlight and wind could increase evaporation rates and
27 the probability of tree 'knockdown'. Due to the increased light levels penetrating the previously
28 shaded interior, shade-intolerant species would be able to grow, and the species composition of
29 the newly created forest edge may change. Clearing could also temporarily reduce local
30 competition for available soil moisture and light and may allow some early successional species
31 to become established and persist on the edge of the uncleared areas adjacent to the milling
32 site. Impacts from clearing this community would be SMALL to MODERATE depending of the
33 amount of surrounding wooded area.

34
35 Noxious weeds that may invade areas disturbed by construction would be controlled through the
36 use herbicides. Application would employ the use of hand sprayers or broadcasting using
37 truck-mounted spraying equipment. If the above methods are used, potential impacts from
38 noxious weeds would be SMALL. Based on the above considerations, potential impacts to
39 wildlife would be SMALL to MODERATE.

40 41 **Wildlife**

42
43 There are three primary impacts of ISL uranium recovery facility construction on terrestrial
44 wildlife: (1) habitat loss or alteration and incremental habitat fragmentation; (2) displacement of
45 wildlife from project construction; and (3) direct and/or indirect mortalities from project
46 construction and operation.

47
48 Construction activities in well-fields would result in some loss of wildlife habitat; however, this
49 loss can be minimized if disturbed areas are reseeded when construction is completed in that
50 area. The impacts would expected to be greatest in vegetative communities where clearing is

1 required to construct wells, access roads, header houses and pipelines from the well fields to
2 the header houses. In general, most wildlife, including the larger and more mobile animals,
3 would disperse from the project area as construction activities approach. Displaced species
4 may re-colonize in adjacent, undisturbed areas or return to their previously occupied habitats
5 after construction ends and a suitable habitat is reestablished. Some smaller, less mobile
6 wildlife such as amphibians, reptiles, and small mammals may die during clearing and grading
7 activities. Small mammals and songbirds dependent on shrubs and trees, for food, nesting, and
8 cover would be impacted in areas where clearing is needed for construction.

9
10 Even if available habitat exists within the site and adjacent areas to support displaced
11 individuals some impact from competition for resources between pre-existing species may
12 occur. Some localized foraging areas may be avoided by big game during construction periods
13 when workers are present. Noise, dust, and increased presence of workers in, or adjacent to,
14 foraging areas may temporarily preclude use by wildlife (NRC, 2004). Habitat loss and
15 fragmentation can be reduced if the percentage of land affected compared to the total
16 undisturbed vegetative community acreage within the permitted area and or surrounding area is
17 minimal. Standard management practices issued by the New Mexico Department of Game and
18 Fish can help to minimize habitat fragmentation, wildlife stress, and incidental death.

19
20 Critical wintering habitat vital for the survival of local elk populations is located within the region
21 (Figure 3.5-9). If a potential facility were to be located within these ranges, guidelines have
22 been issued by the New Mexico Department of Game and Fish. Consultation with the New
23 Mexico Department of Game and Fish would be conducted, and a site-specific analysis
24 performed to determine impacts from the facility to these species.

25
26 Well field operations would require the construction of power distribution lines. Lines would be
27 supported by single pole wood structures with a wooden cross-arm. The conductors would be
28 configured to assure adequate spacing between the shield wire (i.e., ground wire) and
29 conductors to avoid potential electrocution of raptors that land on the cross-arms. Construction
30 of the distribution lines would follow guidance in Suggested Practices for Raptor Protection on
31 Power Lines: The State of the Art in 1996 (Avian Power Line Interaction Committee, 1996).
32 Raptors breeding in the site may be impacted by construction activities or mining operations
33 may be temporarily impacted depending on the time of year construction activities occur.

34
35 To minimize impacts, where possible, the facility would avoid construction in areas within 0.8 km
36 [0.5 mi] of active raptor nests and prior to fledging of young. Mitigation should be carried out in
37 areas that cannot be avoided based on approval by the U.S. Fish and Wildlife Service and the
38 New Mexico Department of Game and Fish. Proposed mitigation could include construction of
39 alternate nest sites on natural features (e.g., trees, rock outcrops, and cliffs), on mine
40 high-walls in the site and vicinity, and erection of appropriate nesting platforms on wooden
41 poles (NRC 2004).

42 43 **Aquatic**

44
45 ISL uranium recovery facility construction primarily affects aquatic resources through:
46 (1) short-term physical disturbances to stream channels; (2) short-term increases in
47 suspended sediments from in-stream activities and erosion from adjacent disturbed lands;
48 (3) increases in downstream sedimentation, during construction, from in-stream activities and
49 erosion from adjacent disturbed lands; (4) potential fuel spills from equipment and refueling
50 operations during construction; and (5) short-term reductions in habitat and potential loss of

1 individual specimens from water appropriations if needed. Impacts to aquatic resources from
2 construction would be similar in nature to those described for other milling regions (SMALL).
3

4 **Threatened and Endangered Species**

5

6 There are three primary impacts of ISL uranium recovery facility construction on threatened and
7 endangered species: (1) habitat loss or alteration and incremental habitat fragmentation;
8 (2) displacement of wildlife from project construction; and (3) direct and indirect mortalities from
9 project construction and operation.
10

11 Numerous Threatened and Endangered Species and State Species of Concern are located
12 within the region. These species with habitat descriptions are provided in Section 3.5.5.3. After
13 a site has been selected, the habitats and impacts would be expected to be evaluated for
14 federal and state species of concern that may inhabit the area. For site-specific environmental
15 reviews, licensees and NRC staff consult with the U.S. Fish and Wildlife Service and New
16 Mexico Department of Game and Fish for potential survey requirements and explore ways to
17 protect these resources. If any of the species are identified in the project site during surveys,
18 potential impacts could range from SMALL to MODERATE to LARGE depending on site-specific
19 conditions. Mitigation plans to avoid and reduce impacts to the potentially affected species
20 would be expected to be developed.
21

- 22 • The Black Footed ferret is reported to be extirpated from New Mexico and is no longer
23 present in the region. No impacts to Black Footed ferrets are expected to occur from
24 milling activities within this region.
25
- 26 • The Bald Eagle has been delisted and is undergoing monitoring. While not a listed
27 species, the bald eagle is still offered protection, and impacts should be avoided.
28 Impacts to this species are unlikely if vegetation during construction removal avoids
29 nesting and hunting habitat along riparian areas.
30
- 31 • The Mexican Spotted Owl has critical habitat designated within the region. Mexican
32 spotted owls nest, roost, forage, and disperse in a diverse assemblage of biotic
33 communities. In the region owls occur primarily in rocky canyons. They nest in these
34 areas on cliff ledges, in stick nests built by other birds, on debris platforms in trees, and
35 in tree cavities. In southern Utah, Colorado, and some portions of northern New Mexico,
36 most nests are in caves or on cliff ledges in rocky canyons. Potential large impacts
37 may occur to this species from land disturbance and woody vegetation from
38 designated habitat.
39
- 40 • The Pecos Puzzle Sunflower found in areas that have permanently saturated soils,
41 including desert wetlands (ciénegas) that are associated with springs, but may include
42 stream and lake margins. The removal of vegetation for construction would have a large
43 impact to this species if found within the construction zone.
44
- 45 • Impacts to the South Western Willow Fly Catcher would occur if the removal of patchy to
46 dense riparian habitats along streams, reservoirs, or other wetlands. Vegetative buffers
47 and avoidance of areas which this species breeds would minimize impacts.
48

- 1 • The Zuni fleabane grows in selenium-rich clay soils derived from the Chinle and Baca
2 formations. Plants are found at elevations from 2,230-2,440 m [7,300–8,000 ft] in
3 pinyon-juniper woodland. Potential impact from vegetation removal may occur to this
4 specie as a result of the facility construction if this specie is found at the facility.
5
- 6 • The Rio Grande Silvery Minnow is believed to occur only in one reach of the Rio Grande
7 in New Mexico, a 280-km [174-mi] stretch of river that runs from Cochiti Dam to the
8 headwaters of Elephant Butte Reservoir. SMALL to MODERATE impacts to this species
9 could occur if vegetation removal, erosion, or sedimentation control measures or not
10 followed during construction if the listed water way occurs within the facility's
11 boundaries.
12
- 13 • Yellow Billed Cuckoo—(candidate) Habitat is described in Section 3.2.5.3 of the
14 Wyoming West Uranium Milling Region
15
- 16 • Surveys conducted in the 1990 determined the distribution of Zuni bluehead (candidate)
17 sucker in New Mexico to be limited mainly to the Río Nutria drainage upstream of the
18 mouth of the Nutria Box Canyon. This included the mouth of Río Nutria box canyon,
19 upper Río Nutria, confluence of Tampico Draw and Río Nutria, Tampico Spring, and
20 Agua Remora. If the listed waterways occur within the permit area potential impacts to
21 this species may occur from construction of crossings and vegetation removal. These
22 impacts would be temporary in nature if re-vegetation and or avoidance of these areas
23 were employed.
24

25 **4.5.5.2 Operation Impacts to Ecological Resources**

26
27 The primary potential impacts of ISL uranium recovery facility operation on terrestrial wildlife
28 are: (1) habitat alteration and incremental habitat fragmentation; (2) displacement/stress of
29 wildlife from human activity; and (3) direct and/or indirect mortalities from project construction
30 and operation.
31

32 Some impacts to wildlife would occur from direct conflict with vehicular traffic and the presence
33 of on site personnel. Generally these are SMALL impacts that would not generally effect the
34 total population of a species. Mitigation guidelines with respect to noise, vehicular traffic, and
35 human proximity have been established by the New Mexico Department of Game and Fish
36 (New Mexico Department of Game and Fish, 2007).
37

38 Potential impacts to migratory birds and other wildlife from exposure to selenium concentrations
39 and radioactive materials in the evaporation ponds may occur. No guidelines have been
40 established concerning acceptable limits for radiation exposure for protection of species other
41 than humans. It is generally agreed that radiation protection standards for humans are
42 conservative for other species (NRC, 2004). The concentrations of radioactive materials in the
43 evaporation ponds are not anticipated to be at levels which could result in significant radiation
44 exposure to biota other than humans. Typically, evaporation ponds are lined with a synthetic
45 liner that inhibits the growth of aquatic vegetation which might otherwise serve as a potential
46 source of exposure to radioactive materials via a food pathway and such vegetation could also
47 potentially provide habitat for wildlife (NRC, 2004). Mitigation measures such as perimeter
48 fencing, surface netting, and the infrequency of wildlife visitation would reduce potential impacts.
49

1 Impacts to the aquatic resources and vegetation from facility operations would be SMALL and
2 generally result from spills around well head and leaks from pipeline that would be handled
3 using best management practices (NRC, 2007). Leak detection systems, spill response plans
4 to remove affected soils and capture release fluids would reduce the impact to aquatic systems.
5 Impacts to federal threatened and endangered species beyond those that occurred during
6 construction would be SMALL. The potential exist for conflict with vehicles to occur during
7 facility operations for those species which are mobile, if they occur in the area.

8 9 **4.5.5.3 Aquifer Restoration Impacts to Ecological Resources**

10 Impacts similar to those found from facility operation are expected as a result of this activity.

11 12 13 **4.5.5.4 Decommissioning Impacts to Ecological Resources**

14
15 Impacts as result from decommissioning would, in part, be similar to those discussed it the
16 construction of the facility, and would be short-termed. The removal of piping would impact
17 vegetation that has re-established itself, and wildlife could come in conflict with heavy
18 equipment. During decommissioning, reclamation activities would re-vegetate previously
19 disturbed vegetative areas and restore streams and drainages to their pre-construction
20 contours. It is expected that temporally displaced wildlife would return to the area.

21 22 **4.5.6 Air Quality Impacts**

23
24 For the Northwestern New Mexico Uranium Milling Region, potential non-radiological air impacts
25 for all four uranium milling phases would be similar to the impacts described for the Wyoming
26 West Uranium Milling Region in Section 4.2.6. The Northwestern New Mexico Uranium Milling
27 Region analyses in Section 4.5.6 would be limited to the modification, supplementation, or
28 summarization of the Wyoming West Uranium Milling Region analyses is presented in
29 Section 4.2.6.

30
31 In general, ISL milling facilities are not major non-radiological air emission sources, and the
32 impacts would be classified as SMALL, if the following conditions are met:

- 33
- 34 • Gaseous emissions are within regulatory limits and requirements
 - 35
 - 36 • Air quality in the region of influence is in compliance with National Ambient Air
37 Quality Standards
 - 38
 - 39 • The facility is not classified as a major source under the New Source Review or
40 operating (Title V) permit programs described in Section 1.7.2
 - 41

42 The Northwestern New Mexico Uranium Milling Region is classified as attainment for National
43 Ambient Air Quality Standards (see Figure 3.5-11). The city of Albuquerque in Bernalillo County
44 is designated as maintenance for carbon monoxide. The northwest part of Bernalillo County is
45 only several kilometers from the Northwestern New Mexico uranium milling region border,
46 however, the Albuquerque is about 50 km [31 mi] from this border. The Northwestern New
47 Mexico Uranium Milling Region does not include any Prevention of Significant Deterioration
48 Class I areas (see Figure 3.5-12). Therefore, the less stringent Class II area allowable
49 increments apply.

1
2 **4.5.6.1 Construction Impacts to Air Quality**
3

4 Nonradiological gaseous emissions in the construction phase include fugitive dust and
5 combustion emissions (Section 2.7.1). Most of the combustion emissions are diesel emissions
6 and are expected to be limited in duration to construction activities and result in small, short-
7 term effects. The Northwestern New Mexico Uranium Milling Region is in NAAQS attainment
8 and contains no Prevention of Significant Deterioration Class I areas. Gaseous emission levels
9 from an ISL facility are expected to comply with applicable regulatory limits and restrictions.
10 Therefore, construction impacts for ISL facilities would be SMALL.

11
12 **4.5.6.2 Operation Impacts to Air Quality**
13

14 Operating ISL facilities are not major point source emitters and are not expected to be classified
15 as major sources under the operation (Title V) permitting program (Section 1.7.2). One
16 gaseous emission source introduced in the operational phase is the release of pressurized
17 vapor from well field pipelines. Excess vapor pressure in these pipelines could be vented at
18 various relief valves throughout the system. In addition, ISL operations may release gaseous
19 effluents during resin transfer or elution. In general, non-radiological emissions from pipeline
20 system venting, resin transfer, and elution are SMALL. Gaseous effluents produced during
21 drying yellowcake operations vary based on the particular drying technology. In general, non-
22 radiological emissions from yellowcake drying would be SMALL.

23
24 Other potential operation phase non-radiological air quality impacts include fugitive dust and
25 combustion emissions from many of the same sources identified earlier in the construction
26 phase. ISL operations phase fugitive dust emissions sources include onsite traffic related to
27 operations and maintenance, employee traffic to and from the site, and heavy truck traffic
28 delivering supplies to the site and product from the site. ISL operations phase would use the
29 existing infrastructure and emissions would not include fugitive dust and diesel emissions
30 associated with well field construction. Therefore, operations phase impacts would be expected
31 to be less than the construction phase impacts.

32
33 The Northwestern New Mexico Uranium Milling Region is in NAAQS attainment and contains no
34 Prevention of Significant Deterioration Class I areas. Gaseous emission levels from an ISL
35 facility are expected to comply with applicable regulatory limits and restrictions. These
36 emissions are not expected to reach levels that result in the ISL facility being classified as a
37 major source under the operating (Title V) permit process. Therefore, operation impacts for ISL
38 facilities would be SMALL.

39
40 **4.5.6.3 Aquifer Restoration Impacts to Air Quality**
41

42 Potential aquifer restoration phase non-radiological air impacts include fugitive dust and
43 combustion emissions from many of the same sources identified earlier in the operations phase.
44 The plugging and abandonment of production and injection wells uses equipment that
45 generates gaseous emissions. These emissions would be limited in duration and result in
46 SMALL, short-term effects. ISL aquifer restoration phase would use the existing infrastructure
47 and the impacts would not exceed those of the construction phase. Therefore, aquifer
48 restoration phase impacts would be SMALL.
49

1 **4.5.6.4 Decommissioning Impacts to Air Quality**

2
3 Potential decommissioning phase non-radiological air impacts include fugitive dust, vehicle
4 emissions and diesel emissions from many of the same sources identified earlier in the
5 construction phase. In the short-term emission levels could increase, especially for particulate
6 matter from activities such as dismantling buildings and milling equipment, removing any
7 contaminated soil, and grading the surface as part of reclamation activities. Decommissioning
8 phase impacts would be expected to be similar to construction phase impacts. Therefore,
9 decommissioning phase impacts would be SMALL.

10
11 **4.5.7 Noise Impacts**

12
13 **4.5.7.1 Construction Impacts to Noise**

14
15 For the Northwestern New Mexico Uranium Milling Region, potential noise impacts during well
16 field construction, drilling, and facility construction would be similar to the impacts described for
17 the Wyoming West Uranium Milling Region in Section 4.2.7.1. There are additional sensitive
18 areas that should be considered within this region (see Section 3.5.7), but because of
19 decreasing noise levels with distance, construction activities would have only SMALL and short-
20 term noise impacts for residences, communities, or sensitive areas located more than about
21 300 m [1,000 ft] from specific noise generating activities. The noise impacts associated with
22 constructing either a central or satellite production facility would be of short duration compared
23 to the operations period. Noise impacts to workers during construction would be SMALL
24 because of adherence to Occupational Safety and Health Administration noise regulations.
25 During construction, wildlife are likely to avoid areas where noise-generating activities were
26 ongoing. Therefore, overall noise impacts during construction would be SMALL to MODERATE.

27
28 **4.5.7.2 Operation Impacts to Noise**

29
30 For the Northwestern New Mexico Uranium Milling Region, potential noise impacts during ISL
31 operations would be similar to the impacts described for the Wyoming West Uranium Milling
32 Region in Section 4.2.7.2. There are additional sensitive areas that should be considered within
33 this region (see Section 3.5.7), but operations at facilities more than 300 m [1,000 ft] from the
34 nearest residence, community, or sensitive area would have only SMALL noise impacts. Noise
35 impacts to workers during operations would be SMALL because of adherence to Occupational
36 Safety and Health Administration noise regulations. During operations, wildlife would be
37 anticipated to avoid areas where noise-generating activities are ongoing. Compared to daily
38 traffic counts of more than 12,000 to 16,000 vehicles per day on Interstate 40 and U.S. Highway
39 491 near Gallup (New Mexico Department of Transportation, 2007; see also Section 3.5.7),
40 additional traffic associated with ISL operations would have only a SMALL impact on noise
41 levels near the highway. As noted in Section 4.2.7.1, noise levels measured at 78 dBA at 30 m
42 [98 ft] would decrease with distance from the highway, to 60 dBA at 360 m [1,180 ft]
43 (Washington State Department of Transportation, 2006). Some country roads with low average
44 annual daily traffic counts would have higher relative increases in traffic and noise impacts, in
45 particular, when facilities are experiencing peak (construction) employment (these impacts
46 would be MODERATE). Therefore, overall noise impacts during operations would be SMALL
47 to MODERATE.

1 **4.5.7.3 Aquifer Restoration Impacts to Noise**

2
3 For the Northwestern New Mexico Uranium Milling Region, potential noise impacts during
4 aquifer restoration would be similar to the impacts described for the Wyoming West Uranium
5 Milling Region in Section 4.2.7.3. There are additional sensitive areas that should be
6 considered within this region (see Section 3.5.7), but for facilities more than 300 m [1,000 ft]
7 from the nearest residence, community, or sensitive area, aquifer restoration would be expected
8 to have only SMALL noise impacts. Noise impacts to workers during operations would be
9 SMALL because of adherence to Occupational Safety and Health Administration noise
10 regulations. Noise impacts to workers during aquifer restoration would also be SMALL because
11 of adherence to Occupational Safety and Health Administration noise regulations. During
12 aquifer restoration, wildlife would be anticipated to avoid areas where noise-generating activities
13 are ongoing. Therefore, overall noise impacts during aquifer restoration would be expected to
14 be SMALL to MODERATE.

15
16 **4.5.7.4 Decommissioning Impacts to Noise**

17
18 For the Northwestern New Mexico Uranium Milling Region, potential noise impacts during
19 aquifer restoration would be similar to the impacts described for the Wyoming West Uranium
20 Milling Region in Section 4.2.7.4. There are additional sensitive areas that should be
21 considered within this region (see Section 3.5.7), but for facilities more than 300 m [1,000 ft]
22 from the nearest residence, community, or sensitive area decommissioning would be expected
23 to have only SMALL noise impacts. Noise impacts to workers during decommissioning would
24 be SMALL because of adherence to Occupational Safety and Health Administration noise
25 regulations. During decommissioning, wildlife would avoid areas where noise-generating
26 activities are ongoing. Therefore, overall noise impacts during decommissioning would be
27 SMALL.

28
29 **4.5.8 Historical and Cultural Resources Impacts**

30
31 Construction-related impacts to cultural resources (defined here as historical, cultural,
32 archaeological, and traditional cultural properties) can be direct or indirect and can occur at any
33 stage of an ISL uranium recovery facility project (i.e, during construction, operation, aquifer
34 restoration, and decommissioning).

35
36 A general cultural overview of the affected environment for the Northwestern New Mexico
37 Uranium Milling Region is provided in Sections 3.5.8 of this GEIS. Construction involving land
38 disturbing activities, such as grading roads, installing wells and constructing surface facilities
39 and well fields, are the most likely to affect cultural and historical resources. Prior to engaging
40 in land disturbing activities, licensees and applicants review existing literature and perform
41 region-specific records searches to determine whether cultural or historical resources are
42 present and have the potential to be disturbed. Along with literature and records reviews, the
43 project site area, and its related facilities and components, would be subjected to a
44 comprehensive cultural resources inventory that meets the requirements of responsible federal,
45 state, and local agencies (e.g., the New Mexico SHPO). The literature and records searches
46 will help identify known or potential historical and cultural resources and Native American sites
47 and features. The cultural resources inventory would identify the previously documented sites
48 and any newly identified cultural resources sites.

1 Licensees and applicants typically consult with the responsible state and tribal agencies to
2 determine the appropriate measures to take (e.g., avoidance, or recording and archiving
3 samples) should new resources be discovered during land disturbing activities at a specific ISL
4 facility. NRC and licensees/applicants may enter into a memorandum of agreement with the
5 responsible state and tribal agencies to ensure protection of historical and cultural resources,
6 if encountered. The eligibility evaluation of cultural resources for listing in the NRHP under
7 criteria in 36 CFR 60.4(a)–(d) and /or as Traditional Cultural Properties is conducted as part of
8 the site-specific review and NRC licensing procedures undertaken during the NEPA review
9 process. The evaluation of impacts to any historic properties designated as Traditional Cultural
10 Properties and tribal consultations regarding cultural resources and Traditional Cultural
11 Properties also occur during the site-specific licensing application and review process.
12 Consultation to determine whether significant cultural resources would be avoided or mitigated
13 occurs during state SHPO, agency, and tribal consultations as part of the site-specific review.
14 Additionally, as needed, the NRC license applicant would be required, under conditions in its
15 NRC license, to adhere to procedures regarding the discovery of previously undocumented
16 cultural resources during initial construction, operation, aquifer restoration, and
17 decommissioning. These procedures typically require the licensee to stop work and to notify the
18 appropriate federal and state agencies.

19
20 Licensees and applicants typically consult with the responsible state and tribal agencies to
21 determine the appropriate measures to take (e.g., avoidance or mitigation) should new
22 resources be discovered during land disturbing activities at a specific ISL facility. NRC,
23 licensees and applicants may enter into memoranda of understanding with the responsible state
24 and tribal agencies to ensure protection of historical and cultural resources, if encountered.

25 26 **4.5.8.1 Construction Impacts to Historical and Cultural Resources**

27
28 Most of the potential for significant adverse effects to NRHP-eligible, or potentially NRHP-
29 eligible, historic properties and traditional cultural properties, both direct and indirect, would
30 likely occur during land-disturbing activities related to building an ISL uranium recovery facility.
31 Buried cultural features and deposits that are not visible on the surface during initial cultural
32 resources inventories could be discovered during earth-moving activities.

33
34 Indirect impacts may also occur outside the ISL uranium recovery project site and related
35 facilities and components. Visual intrusions, increased access to formerly remote or
36 inaccessible resources, impacts to traditional cultural properties and culturally significant
37 landscapes, such as Mt. Taylor, as well as other ethnographically significant cultural landscapes
38 may adversely affect these resources. These significant cultural landscapes should be
39 identified during literature and records searches and may require additional archival,
40 ethnographic, or ethnohistorical research that encompasses areas well outside the area of
41 direct impacts. Indirect impacts to some of these cultural resources may be unavoidable and
42 exist throughout the lifecycle of an ISL uranium recovery project.

43
44 Because of the localized nature of land disturbing activities related to construction, impacts to
45 cultural and historical resources are anticipated to be SMALL, unless the facility is located
46 adjacent to a known resource. New Mexico historical sites and traditional cultural properties are
47 described in Section 3.5.8. Proposed facilities or expansions adjacent to these properties and
48 other tribal lands would be likely to have the greatest potential impacts, and mitigation measures
49 (e.g., avoidance, recording and archiving samples) and additional consultations with affected
50 Native American tribes would be needed to reduce the impacts. From the standpoint of cultural

1 resources, the most significant impacts to any sites that are present would occur during the
2 initial construction within the area of potential effect. Subsequent changes in the footprint of the
3 project, that is, expansion outside of the original area of potential effect, may also result in
4 significant impact to any cultural resources that might be present.

5 6 **4.5.8.2 Operation Impacts to Historical and Cultural Resources**

7
8 Depending on the location, both direct and indirect adverse effects on NRHP-eligible, potentially
9 NRHP-eligible historical properties, traditional cultural properties, and other cultural resources
10 are possible during operation of an ISL uranium recovery project. Potential impacts during
11 operation would be expected to occur through new earth-disturbing activities, new construction,
12 maintenance and repair.

13
14 Inadvertent impacts to historic and cultural resources located within the extended ISL permitted
15 area and other cultural landscapes that are identified before construction are expected to
16 continue during operation. Overall impacts to cultural and historical resources during operations
17 are expected to be less than those during construction, as operations are generally limited to
18 previously disturbed areas (e.g., access roads, central processing facility, well sites), and would
19 be SMALL.

20 21 **4.5.8.3 Aquifer Restoration Impacts to Historical and Cultural Resources**

22
23 Depending on the location, both direct and indirect adverse effects on NRHP-eligible, potentially
24 NRHP-eligible historical properties, traditional cultural properties, and other cultural resources
25 are possible during the aquifer restoration phase of an ISL uranium recovery project. Potential
26 impacts during aquifer restoration may occur through new earth-disturbing activities or other
27 new construction that may be required for the restoration process. Such activities may have
28 inadvertent impacts to historical and cultural resources and traditional cultural properties in or
29 near the site of aquifer restoration activities located within the extended ISL project area.

30
31 Inadvertent impacts to historic and cultural resources located within the extended ISL permitted
32 area and other cultural landscapes that are identified before construction are expected to
33 continue during aquifer restoration. Overall impacts to cultural and historical resources during
34 aquifer restoration are expected to be less than those during construction, as aquifer restoration
35 activities are generally limited to previously disturbed areas (e.g., access roads, central
36 processing facility, well sites), and would be SMALL.

37 38 **4.5.8.4 Decommissioning Impacts to Historical and Cultural Resources**

39
40 Depending on the location, both direct and indirect adverse effects on NRHP-eligible, potentially
41 NRHP-eligible historical properties, traditional cultural properties, and other cultural resources
42 are possible during the decommissioning phase of an ISL uranium recovery project. Potential
43 impacts can result from earth-disturbing activities that may be required for the decommissioning
44 process. Inadvertent impacts to cultural resources and traditional cultural properties in or near
45 the site of decommissioning activities may potentially occur.

46
47 Inadvertent impacts to historic and cultural resources located within the extended ISL permitted
48 area and other cultural landscapes that are identified before construction are expected to
49 continue during aquifer restoration. Overall impacts to cultural and historical resources during
50 decommissioning are expected to be less than those during construction, as decommissioning

1 activities are generally limited to previously disturbed areas (e.g., access roads, central
2 processing facility, well sites). Impacts to previously known historical, cultural, archaeological
3 and traditional cultural properties documented during the initial inventory during
4 decommissioning can result from earth-disturbing activities that may be required for the
5 decommissioning process. Because cultural resources within the existing area of potential
6 effect are known, potential impacts can be avoided or lessened by redesign of decommissioning
7 project activities.
8

9 **4.5.9 Visual/Scenic Resources Impacts**

10 **4.5.9.1 Construction Impacts to Visual/Scenic Resources**

11
12
13 During construction, most impacts to visual resources in the Northwestern New Mexico Uranium
14 Milling Region would be similar to those in the Wyoming West Uranium Milling Region. Most
15 visual and scenic impacts associated with drilling and other land-disturbing construction
16 activities would be temporary. Roads and structures would be more long-lasting, but would be
17 removed and reclaimed after operations cease. As noted in Section 3.5.9, most of the areas in
18 the affected environment of the Northwestern New Mexico Uranium Milling Region are identified
19 as Visual Resource Management Class II through Class IV according to the BLM classification
20 system. In the Northwestern New Mexico Uranium Milling Region, a number of VRM Class II
21 areas surrounding the national monuments (El Morro, and El Malpais), the Chaco Culture
22 National Historic Park, and the sensitive areas managed within the Mt. Taylor district of the
23 Cibola National Forest would have the most potential for impacts to visual resources. Most of
24 these areas, however, are located to the north, south, and east of the potential ISL facilities, at
25 distances of 16 km [10 mi], or more. The facilities would be located in VRM Class III and IV
26 areas. Current understanding indicates that several potential ISL facilities may be located near
27 the Navajo Nation or near Mt. Taylor in the San Mateo Mountains. The general visual and
28 scenic impacts associated with ISL facility construction are anticipated to be temporary and
29 SMALL. However, from a Native American perspective, any construction activities are likely to
30 result in adverse impacts to the landscape, particularly for facilities located in areas within view
31 of tribal lands and areas of special significance such as Mt. Taylor.
32

33 **4.5.9.2 Operation Impacts to Visual/Scenic Resources**

34
35 Similar to the visual impacts described for the Wyoming West Uranium Milling Region discussed
36 in Section 4.2.9.2, the potential visual and scenic impacts from ISL operations in the
37 Northwestern New Mexico Uranium Milling Region would be SMALL, and the same as, or less than
38 those impacts associated with construction. For example, in a similar assessment for the
39 Farmington Field Office area near Grants, New Mexico, BLM estimated that drilling associated
40 with oil and gas lease development would minimally change the visual quality of the landscape
41 (BLM, 2003). The greatest potential for visual impacts would be from new facilities developed in
42 rural, previously undeveloped areas, or within view of the sensitive regions described in
43 Sections 3.5.9 and 4.5.9.1.
44

45 **4.5.9.3 Aquifer Restoration Impacts to Visual/Scenic Resources**

46
47 Similar to the potential visual impacts described for the Wyoming West Uranium Milling Region
48 discussed in Section 4.2.9.3, the potential visual and scenic impacts from ISL aquifer restoration
49 operations in the Northwestern New Mexico Uranium Milling Region would be SMALL. Aquifer

1 restoration would not occur until after the facility had been in operation for a number of years,
2 and potential impacts would be the same as, or less than, during the operations period.
3 Although overall impacts from aquifer restoration activities would be the same as, or less than,
4 those for construction and operation, the potential visual impacts would be greatest for facilities
5 located in previously undeveloped areas or within view of the sensitive regions described in
6 Sections 3.5.9 and 4.5.9.1.

7 8 **4.5.9.4 Decommissioning Impacts to Visual/Scenic Resources**

9
10 Similar to the potential visual impacts described for the Wyoming West Uranium Milling Region
11 discussed in Section 4.2.9.4, the potential visual and scenic impacts from decommissioning and
12 reclaiming ISL facilities in the Northwestern New Mexico Uranium Milling Region would be
13 SMALL. Decommissioning and reclamation activities would occur after the facility had been in
14 operation for a number of years, and one of the purposes of the decommissioning process is to
15 remove surface infrastructure and reclaim the area to pre-operational conditions. This would
16 result in less visual contour for the facility. Although overall impacts from decommissioning and
17 reclamation activities would be the same as or less than those for construction and operation,
18 the potential visual impacts would be greatest for facilities located in previously undeveloped
19 areas or within view of the sensitive regions described in Sections 3.5.9 and 4.5.9.1.

20 21 **4.5.10 Socioeconomic Impacts**

22
23 Although a proposed facility size and production level can vary, the peak annual employment at
24 an ISL facility range up to about 200 people, including construction (Freeman and Stover, 1999;
25 NRC, 1997; Energy Metals Corporation, U.S., 2007). Depending on the composition and size of
26 the local workforce, overall socioeconomic impacts from ISL milling facilities for the
27 Northwestern New Mexico Uranium Milling Region would range from SMALL to MODERATE.

28
29 Assuming the number of persons per household in New Mexico is about 3.6 (U.S. Census
30 Bureau, 2008), the number of people associated with an ISL facility workforce could be as many
31 as 720 (i.e., 200 workers times 3.6 persons/household). The demand for public services
32 (schools, police, fire, emergency services) would be expected to increase with the construction
33 and operation of an ISL facility. There may also be additional standby emergency services not
34 be available in some parts of the region. It may be necessary to develop contingency plans
35 and/or additional training for specialized equipment. Infrastructure (streets, waste management,
36 utilities) for the families of a workforce of this size would also be affected.

37 38 **4.5.10.1 Construction Impacts to Socioeconomics**

39
40 The majority of construction requirements would likely be filled by a skilled workforce from
41 outside of the Northwestern New Mexico Uranium Milling Region. Assuming a peak workforce
42 of 200, this influx of workers is expected to result in SMALL to MODERATE impact in the
43 Northwestern New Mexico Uranium Milling Region. Impacts would be greatest for communities
44 with small populations, such as Tohatchi (pop. 1,000) in McKinley County, and Laguna (pop.
45 400) in Cibola County. However, due to the short duration of construction (12-18 months),
46 workers would have only a limited effect on public services and community infrastructure.
47 Further, construction workers are less likely to relocate their entire family to the region, thus
48 minimizing impacts from an outside workforce. In addition, if the majority of the construction

1 workforce is filled from within the region, impacts to population and demographics would be
2 SMALL.

3
4 Construction impacts to regional income and the labor force for a single ISL facility in the
5 Northwestern New Mexico Uranium Milling Region would likely be SMALL. In addition, even if
6 multiple facilities be developed concurrently, the potential for impact upon the labor force would
7 still be SMALL. For example, the Town of Grants, Cibola County, has a labor force of 3,800. It
8 would require two ISL facilities to be constructed simultaneously to affect the labor market of
9 just the Town of Grants by only 10 percent, if all the workers came from the Town of Grants,
10 alone. Construction of an ISL is likely, to the extent possible, to draw upon the labor force
11 within the region before going outside the region (and state). The greatest economic benefit to
12 the region would be to have the labor force drawn from within the region. However, economic
13 benefit may still be achieved (in the form of the purchased of goods and services) even if the
14 labor force is derived from outside the region. The potential impact upon smaller communities
15 (Tohatchi and Laguna) could be MODERATE.

16
17 Impacts to housing from construction activities would be expected to be SMALL (and short-
18 termed) even if the workforce is primarily filled from outside the region. It is likely that the
19 majority of construction workers would use temporary housing such as apartments, hotels, or
20 trailer camps. Many construction workers use personal trailers for housing on short-term
21 projects. Impacts on the region's housing market would, therefore, be considered SMALL.
22 However, the impact upon specific facilities (apartment complexes, hotels, or campgrounds)
23 could potentially be MODERATE, if construction workers concentrated in one general area.

24
25 Assuming the majority of employment requirements for construction are filled by outside
26 workers (a peak of 200), there would be SMALL to MODERATE impacts to employment
27 structure. The use of outside workforce would be expected to have MODERATE impacts to
28 communities with high unemployment rates. If the majority of construction activities rely on the
29 use of a local workforce, impacts would be anticipated to be SMALL to MODERATE depending
30 upon the size of the local workforce. Communities such as the Town of Grants and the Native
31 American communities in the Indian Reservations (Acoma, Tohajiilee, Laguna, Navajo Nation,
32 Ramah Navajo, and Zuni) would experience MODERATE impacts, due to their high
33 unemployment rate and potential increase in employment opportunities.

34
35 Local finance would be affected by ISL construction through additional taxation and the
36 purchase of goods and services. New Mexico has a personal income tax that ranges from 1.7 –
37 5.3 percent. In addition, it has a gross receipt sales tax. Construction workers are anticipated
38 to contribute to these as they purchase goods and services within the region and within the
39 state while working on an ISL facility. In addition, and more significant, is the 'ad valorem
40 production tax' and the 'ad valorem production equipment tax.' In 2000 for minerals other than
41 oil and gas the state collected \$ 8.9 million from this tax (New Mexico Taxation and Revenue
42 Department). It is anticipated that ISL facility development could have a MODERATE impact on
43 local finances within the region.

44
45 Even if the majority of workforce is filled from outside, impacts to education from construction
46 activities would be SMALL. This is because construction workers are less likely to re-locate
47 their entire family for a relatively short duration (12-18 months). Impacts to education from a
48 local workforce would also be SMALL, as they are already established in the community.

1 Potential impacts from construction (from either the use of local or outside [non-regional]
2 workforce) to local health services such as hospitals or emergency clinics would be SMALL.
3 Accidents resulting from construction of an ISL facility are not expected to be different than
4 other types of similar industrial facilities.

5 6 **4.5.10.2 Operational Impacts to Socioeconomics**

7
8 Operational requirements of an ISL necessitate the use of
9 specialized workers, such as plant managers, technical
10 professionals, and skilled tradesmen. While operational
11 activities would be longer term (20-40 years) than
12 construction (12-18 months), instead of up to 200 workers,
13 an operating ISL generally requires a labor force of from
14 50 to 80 personnel. If the majority of operational
15 requirements are filled by a workforce from outside the
16 region, assuming a multiplier of about 0.7 (see text box),
17 there could be an influx of between 35 and 56 jobs (i.e.,
18 $50-80 \times 0.7$) per ISL facility (up to 200, including families).

19 The potential impact to the local population and public
20 services resulting from the influx of workers and their families would range from SMALL to
21 MODERATE, depending upon the location (proximity to a population center) of an ISL within the
22 region. However, because an outside workforce would be more likely to settle into a more
23 populated areas with increased access to housing, schools, services, and other amenities,
24 these impacts may be reduced. If the majority of labor is of local origin, potential impacts to
25 population and public services would be expected to be SMALL, as the workers would already
26 be established in the region.

Economic Multipliers

The economic multiplier is used to summarize the total impact that can be expected from change in a given economic activity. It is the ratio of total change to initial change. The multiplier of 0.7 was used as a typical employment multiplier for the milling/mining industry (Economic Policy Institute, 2003).

27
28 It is assumed, however, that because of the highly technical nature of ISL operation (requiring
29 professionals in the areas of health physics, chemistry, laboratory analysis, geology and
30 hydrogeology, and engineering), the majority (approximately 70 percent) of the work force (35 to
31 56 personnel) would be staffed from outside the region for, at least, the initial ISL facility.
32 Subsequent ISL facilities may draw personnel from established or decommissioned facilities.
33 This is expected to have a SMALL impact upon the regional labor force.

34
35 If it is assumed that as many as 56 families (80 workers \times 0.7 economic multiplier) are required
36 to relocate into the Northwestern New Mexico Uranium Milling Region, the most likely available
37 housing markets would be located in the larger communities, such as Gallup and Grants (within
38 the region), and Albuquerque (located outside the region). Unless the workforce is distributed
39 throughout the region, the impact of an ISL on the housing market would be MODERATE,
40 depending upon location, due to the limited number of available units.

41
42 Impacts to income and the labor force structure within the Northwestern New Mexico Uranium
43 Milling Region would be similar to construction impacts, but longer in duration. Impacts from
44 ISL operation would be SMALL to MODERATE, depending on where the majority of the
45 workforce settles.

46
47 Assuming a local workforce is used, there would be SMALL impacts to the local employment
48 structure, and would be similar to construction impacts. If the entire labor force for the ISL
49 facility came from outside the affected community, the workforce would be SMALL to

1 MODERATE relative to the employment structure for most of the affected counties. Impacts
2 from inflow of an outside workforce would be similar to construction impacts.

3
4 Assuming the majority of workforce is derived from outside the Northwestern New Mexico
5 Uranium Milling Region, potential impacts to education from operation activities would be
6 SMALL. Even though the number of people associated with an ISL facility workforce could be
7 as much as 200 (including families), there would be about 90 school-aged children involved.
8 There are five school districts in the region. If all of the ISL worker's children were to enroll in
9 the Grants school district (the region's smallest, with only 2,414 pupils), there would only be a 4
10 percent increase in the student population.

11 Effects on other community services (health care, utilities, shopping, recreation, etc.) during
12 operation are anticipated to be similar to construction (less in volume/quantity, but longer in
13 duration). Therefore, the potential impacts would be SMALL.

14 15 **4.5.10.3 Aquifer Restoration Impacts to Socioeconomics**

16
17 The same ISL facility components and workforce would be involved in aquifer restoration as
18 during operations use. Thus, the number of personnel involved would also be the same, and
19 the potential impacts would be similar. These potential impacts would extend beyond the life of
20 the facility (typically 2-10 years), but still would be SMALL.

21
22 Income and labor force requirements during aquifer restoration are anticipated to be the same
23 as during operations (technical requirements are similar), and therefore, potential impacts would
24 be SMALL.

25
26 The employment structure during aquifer restoration would be expected to be unchanged and
27 continue after the operational phase. However, a smaller number of specialized workers may
28 be required to return the site to pre-ISL levels. The potential impacts to the region would be
29 considered SMALL.

30
31 Impacts to housing, education, health, and social services during aquifer restoration would also
32 be expected to be the similar to operations, but continues beyond the life of the site. The overall
33 potential impacts would be SMALL.

34 35 **4.2.10.4 Decommissioning Impacts to Socioeconomics**

36
37 Decommissioning is, essentially, deconstruction, and is expected to require a similar work force
38 (up to 200 personnel), with similar skills, as the construction phase. The impacts to affected
39 communities in the Northwestern New Mexico Uranium Recovery Region during
40 decommissioning would, therefore, be similar to the construction phase. The decommissioning
41 phase may last up to a year longer than the construction phase, depending upon the condition
42 of the ISL at termination. However, the overall potential impacts are still expected to be SMALL
43 to MODERATE,

44
45 The income levels and labor force requirements during decommissioning are also anticipated to
46 be similar to the construction phase, and the potential impacts to the region would, therefore, be
47 considered SMALL to MODERATE.

1 The employment structure during decommissioning would be similar to the construction phase;
2 however, a reduction of workforce would result towards the end of the decommissioning phase.
3 Impacts to employment would be SMALL to MODERATE.
4

5 Potential impacts to housing during the decommissioning phase would be similar to the
6 construction phase and would be SMALL for the larger communities within the region, but may
7 be MODERATE if the temporary housing was to be concentrated in a smaller community.
8

9 Decommissioning would be expected to involve similar numbers (up to 200) of workers (likely
10 without families) because of the short-duration of the activity) as construction. Therefore, the
11 anticipated impacts to the local education system would be SMALL.
12

13 Impacts to community services (health care, entertainment, shopping, recreation) would also be
14 similar to construction, and thus, would be considered SMALL.
15

16 **4.5.11 Public and Occupational Health and Safety Impacts**

17 **4.5.11.1 Construction Impacts to Public and Occupational Health and Safety**

18 Construction impacts to public and occupational health and safety for the Northwestern New
19 Mexico Uranium Milling Region would be similar to those discussed for the Wyoming West
20 Uranium Milling Region in Section 4.2.11.1.
21
22

23 **4.5.11.2 Operation Impacts to Public and Occupational Health and Safety**

24 **4.5.11.2.1 Radiological Impacts to Public and Occupational Health and Safety From** 25 **Normal Operations**

26 Estimated doses to members of the public are reported for a variety of commercial-scale and
27 satellite facilities in section 4.2.11.2.1. As shown, these doses are well below the public dose
28 limit of 1 mSv/yr [100 mrem/yr]. Doses at other locations could be higher or lower depending on
29 a variety of factors including receptor location, topography, and weather conditions. When
30 releases occur from ground level, doses decrease the farther the receptor is away from the
31 release location because the radioactive material is diluted as the wind mixes it. The amount of
32 dilution, which is referred to as dispersion, is determined by the weather (meteorological
33 conditions). For areas in which meteorological conditions are more stable (less turbulent), a
34 higher dose could occur. As the radioactive material travels via the wind, changes in
35 topography can affect the dose received by the receptor. Doses for the various ISL facilities
36 shown in Table 4.2-2 are at least a factor of three below the regulatory limit and most are much
37 less than that. Doses at operating ISL facilities in different regions are not likely to exceed
38 regulatory limits, and overall impacts to public and occupational health and safety would
39 be SMALL.
40
41
42

43 **4.5.11.2.2 Radiological Impacts to Public and Occupational Health and Safety** 44 **From Accidents**

45 The consequences of potential accidents are expected to be similar regardless of an ISL
46 facility's location and are described in Section 4.2.11.2.2. Distance to the nearest receptor,
47 topography, and meteorological data account for potential differences in resulting dose. For
48
49

1 facilities in which the maximally exposed offsite individual would be closer, there would be
2 higher doses for ground-level releases. Changes in topography could also have an impact on
3 the resulting dose since this would allow the receptor to be closer to, or farther away, from the
4 radioactive material as it travels by wind. Meteorological conditions vary based on location and
5 could result in a higher or lower dose. The consequences resulting from a potential unmitigated
6 accident would have a SMALL effect on the general public and, at most, a MODERATE affect
7 on the workers.

8
9 **4.5.11.2.3 Non-radiological Impacts to Public and Occupational Health and Safety From**
10 **Normal Operations**

11
12 While hazardous chemicals are used at ISL facilities (Section 2.4.2) SMALL risks would be
13 expected in the use and handling of these chemicals during normal operations at ISL facilities.
14 However, accidental releases of these hazardous chemicals can produce significant
15 consequences and impact public and occupational health and safety. An analysis of such
16 hazards and potential risks for impacts is provided in the following section.

17
18 **4.5.11.2.4 Non-radiological Impacts to Public and Occupational Health and Safety**
19 **From Accidents**

20
21 Non-radiological impacts to public and occupational health and safety for the Northwestern New
22 Mexico Uranium Milling Region are expected to be similar to impacts discussed for the
23 Wyoming West Uranium Milling Region in Section 4.2.11.2.4. Compliance with applicable 10
24 CFR Part 20, EPA, and Occupational Safety and Health Administration requirements would safe
25 handling of radiological and hazardous materials. The likelihood of accidental releases would
26 be reduced, and the impacts would be SMALL.

27
28 **4.5.11.3 Aquifer Restoration Impacts to Public and Occupational Health and Safety**

29
30 Aquifer restoration impacts on public and occupational health and safety would be similar to
31 operational impacts discussed in Section 4.5.11.2.

32
33 **4.5.11.4 Decommissioning Impacts to Public and Occupational Health and Safety**

34
35 During ISL facility decommissioning, hazards are removed or reduced, surface soils and
36 structures are decontaminated, and disturbed lands are reclaimed. As a result of these
37 activities, some SMALL impacts could potentially occur.

38
39 To ensure the safety of workers and the public during decommissioning, the NRC requires
40 licensed facilities to submit a decommissioning plan for review (Section 2.6). Such a plan
41 includes details of how a 10 CFR Part 20 compliant radiation safety program would be
42 implemented during decommissioning to ensure safety of workers and the public is maintained
43 and applicable safety regulations are complied with. A combination of: (1) NRC review and
44 approval of these plans, (2) the application of site-specific license conditions where necessary,
45 and (3) regular NRC inspection and enforcement activities to ensure compliance with radiation
46 safety requirements constrain the magnitude of potential public and occupational health impacts
47 from ISL facility decommissioning actions to acceptable (SMALL) levels.
48

1 **4.5.12 Waste Management Impacts**
2

3 Waste management impacts for the Northwestern New Mexico Uranium Milling Region are
4 expected to be similar to the impacts discussed for the Wyoming West Uranium Milling Region
5 in Section 4.2.12. because the waste volumes, management practices, waste management
6 safety and environmental concerns, waste management permitting and regulations, and
7 relevant aspects of the NRC licensing are not expected to change significantly (either in practice
8 or effectiveness) with facility location from one region to another.
9

10 **4.5.12.1 Construction Impacts to Waste Management**
11

12 The relatively small scale of construction activities (Section 2.3) and incremental development
13 of well fields at ISL facilities generate low volumes of construction waste. Table 2.7-1, which
14 includes a listing of engine-driven construction equipment needed for construction of a satellite
15 ISL facility provides insights into the magnitude of well field construction activities. As a result of
16 the limited volumes of construction waste that would be generated by ISL facility construction,
17 waste management impacts from construction would be SMALL.
18

19 **4.5.12.2 Operation Impacts to Waste Management**
20

21 Operations waste management impacts for the Northwestern New Mexico Uranium Milling
22 Region are expected to be similar to the impacts discussed for the Wyoming West Uranium
23 Milling Region in Section 4.2.12.2 because the waste volumes, management practices, waste
24 management safety and environmental concerns, waste management permitting and
25 regulations, and relevant aspects of the NRC licensing are not expected to change significantly
26 (either in practice or effectiveness) with facility location from one region to another. Operational
27 waste management impacts would be SMALL, based on the required pre-operational disposal
28 agreement for byproduct material, regulatory controls including applicable permitting, license
29 conditions, and inspection practices, and typical facility design specifications and management
30 practices including waste treatment and volume reduction techniques, pond leak detection, and
31 other routine monitoring activities.
32

33 **4.5.12.3 Aquifer Restoration Impacts to Waste Management**
34

35 Waste management activities during aquifer restoration utilize the same treatment and disposal
36 options implemented for operations, therefore, impacts associated with aquifer restoration would
37 be similar to the operational impacts discussed in Section 4.5.12.2. Additional waste water
38 volume and the associated volume of water treatment wastes may be generated during aquifer
39 restoration; however, this would be offset to some degree by the reduction in production
40 capacity from the removal of a well field from production activities. While the amount of waste
41 water generated during aquifer restoration is dependent on site-specific conditions, Section
42 2.5.2 provides an illustrative estimate of water volume per pore volume and Section 2.11.5
43 provides experience regarding the number of pore volumes required for aquifer restoration in
44 past efforts). Furthermore, the NRC review of future ISL facility licensing would verify that
45 sufficient water treatment and disposal capacity (and the associated agreement for disposal of
46 byproduct material discussed in Section 4.2.12) are addressed. As a result, waste management
47 impacts from aquifer restoration would be SMALL.
48
49

1 **4.5.12.4 Decommissioning Impacts to Waste Management**
2

3 Decommissioning waste management impacts for the Northwestern New Mexico Uranium
4 Milling Region are expected to be similar to the impacts discussed for the Wyoming West
5 Uranium Milling Region in Section 4.2.12.4 because the waste volumes and management
6 practices, waste management safety and environmental concerns, waste management
7 regulations, and relevant aspects of the NRC licensing are not expected to change significantly
8 (either in practice or effectiveness) with facility location from one region to another. The
9 required pre-operational agreement for disposal of byproduct material, NRC review and
10 approval of a decommissioning plan and radiation safety program, and the small volume of solid
11 waste generated for offsite disposal suggest the waste management impacts would be SMALL.
12 Related transportation impacts are discussed separately in Section 4.5.2.
13

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8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Programs
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)

Wyoming Department of Environmental Quality, Land Quality Division (Cooperating Agency)
122 West 25th Street, Herschler Building
Cheyenne, Wyoming 82002

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

This Draft Generic Environmental Impact Statement (Draft GEIS) was prepared in compliance with the National Environmental Policy Act (NEPA) of 1969 and NRC regulations for implementing NEPA found at Title 10, "Energy," of the U.S. Code of Federal Regulations (CFR) Part 51 (10 CFR Part 51). This Draft GEIS evaluates on a programmatic basis, the potential environmental impacts associated with the construction, operation, ground water restoration, and decommissioning of uranium milling facilities employing the in-situ leach (ISL) process.

In the ISL process, a leaching agent, such as oxygen with sodium bicarbonate, is added to native ground water for injection through wells into the subsurface ore body to dissolve the uranium. The leach solution, containing the dissolved uranium, is pumped back to the surface and sent to the processing plant, where ion exchange is used to separate the uranium from the solution. The underground leaching of the uranium also frees other metals and minerals from the host rock. Operators of ISL facilities are required to restore the ground water affected by the leaching operations. The milling process concentrates the recovered uranium into the product known as "yellowcake" (U3O8). This yellowcake is then shipped to uranium conversion facilities for further processing in the overall uranium fuel cycle.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Uranium Recovery
In-Situ Leach Process
Uranium
Environmental Impact Statement

13. AVAILABILITY STATEMENT

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14. SECURITY CLASSIFICATION

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