Attachment 3
Net Environmental Benefit Analysis

BEFORE THE OIL CONSERVATION DIVISION
Santa Fe, New Mexico
Exhibit No. 6
Submitted by:
SOUTHWEST ROYALTIES, INC.
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Attachment 3: Net Environmental Benefit Analysis

Explanation of Scoring

The alternatives considered for a semi-quantitative Net Environmental Benefit Analysis (NEBA) for surface restoration at the SW Royalties Arco Federal Tank Battery are:

A. Dig and haul all impacted soil with chloride >1,000 ppm to a maximum depth of 5-feet, import clean fill and amendments.
B. Dig and haul hot spots (>2,000 ppm chloride, maximum depth 3-feet), import clean fill and blend to <1,000 ppm chloride.
C. Dig up hot spots (>2,000 ppm chloride, maximum depth 3-feet) and dispose of impacted soil in on-site trench, import fill (from trench) and blend to <1,000 ppm.
D. Dig up hot spots and dispose of impacted soil in on-site trench, import some soil from trench, create depression for water collection, use water plus "straw" to restore native soil.
E. Dig and haul hot spots, install liner "shingles" 4' below ground surface, import fill for area above liner and blend.
F. Remove surface caliche, rip and disc site, add amendments.

NEBA methodologies are described by several authors, including:

- Efroymson and others (2003, esd.ornl.gov/programs/ecorisk/documents/NEBA-petrol-s-report-RE.pdf)
- Robertson (2006, *www.freshwaterspills.net/neba/neba.ppt*)
- ASTM (2006, http://www.astm.org/Standards/F2532.htm)
- Kealy and others (2001, www.iosc.org/papers/01338.pdf)

For the Arco Federal Battery site, we elected to modify the NEBA method described by Robertson (2006) and ASTM (2006). Because the site comprises less than 1-acre, the use of Habitat Equivalency Metrics, as presented by Kealy and others (2001) is not appropriate. While Robertson uses a color-coded ranking system (green, yellow, red) that allows the user of the NEBA to visually discern which response action provides a more favorable outcome, we used a numerical ranking system where a score of 3 provides the greatest benefit (or least harm), and a ranking of 1 provides the least benefit.

Each criterion has two multiplying factors: one that considers the importance to stakeholders and a second that considers the importance of the criteria to the site-specific environmental setting. In theory, the site-specific environmental setting would be established by good data. In practice, one stakeholder may conclude that site data demonstrate the absence of a water table aquifer beneath the site. According to that stakeholder, ground water quality cannot be impaired and a site multiplication factor of zero is appropriate. Another stakeholder may conclude that data do not demonstrate with a reasonable degree of scientific certainty that a water table aquifer is absent. This second stakeholder may assign a site multiplication factor of 2. Consensus, which is critical to the NEBA process, could create a final site multiplication factor of 0.5, 1 or zero – depending upon which stakeholder is most convincing to the group.

The stakeholder multiplication factor considers the importance of the criteria to the stakeholder. A stakeholder with a surface grazing lease may have sufficient water supplied by a pipeline or nearby source and protecting ground water quality beneath the site may not be important. To this surface leaseholder, forage for livestock may be the most important criteria and assigned a multiplication factor of 3 while protection of ground water would be assigned a factor of 1. Consensus may create a simple average of the various stakeholder scores.

The score and the two multiplication factors are used to calculate a weighted value for each remedy. This weighted value = (Site Multiplication Factor*Score) + (Stakeholder Multiplication Factor * Score).

At this time, the stakeholder multiplication factor is essentially a placeholder as we need additional input from the BLM, adjacent landowners and surface users. Most publications that describe the NEBA process emphasize that success requires a consensus among stakeholders. This DRAFT report is the first step in creating a consensus between all stakeholders. After review of this DRAFT by BLM, we would anticipate a review by surface and subsurface lessees, nearby landowners and possibly the NMOCD.

Ground Water

Data demonstrate that ground water is not present at the site (see Hicks Consultants letter to NMOCD, 2-2-11). Therefore, the multiplication factor for site conditions and stakeholders is zero and scoring is not warranted.

Surface Water

A surface water body (a playa or an arroyo that may hold water for several days) is not present in the area. This condition creates a multiplication factor for surface water of zero for both the site and stakeholders.

Air Quality

Dust generation

Our evaluation suggests that the footprint of the historic release(s) covers slightly less than 10,500 square feet. Data suggest that soil with a chloride concentration greater than 1,000 ppm exists to a depth of 4-8 feet beneath this footprint. Under Remedy A, we estimate that dust generation would occur due to the excavation of the site to an average depth of 5-feet, generating a total of 2,528 cubic yards of soil. The transport of 126 belly-dump trucks over about 1-mile of dirt road toward the landfill would generate additional dust. We assigned a score of 1 for Remedy A. For the purposes of this evaluation, we estimate that excavation and removal of "hot spots" (>2,000 ppm chloride) to a depth of about 4-feet will generate about 1,463 cubic yards of soil requiring transport (Remedies B and E), thus, Remedies B and E will generate about 40% less dust than Remedy A. Remedies C and D call for excavation to 4-feet and generate the same 1,463 cubic yards of soil but avoids transport along the dirt road through on-site trench burial thus creating slightly less dust than Remedies B or E. Because Remedies B, C, D, and E generate about the same volume of dust, all receive a score of 2. Remedy F will require some removal of asphaltic soil and caliche prior to ripping/discing and adding

amendments of straw (to increase soil permeability) and water (to flush chloride below the root zone). As a result, Remedy F will generate the least dust, and we assigned a score of 3 to Remedy F.

Assigned Values for Dust Generation

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Weighted Value, Dust Generation
A	1	1	1	2
B	2			4
C	2			4
D	2			4
E	2			4
F	3			6

During the next 1-5 years, which is the timeframe anticipated to achieve a successful remedy at the Arco Federal Battery site, oil and gas operations in the area will create a significant amount of dust. The incremental contribution of any of the remedies is very small in comparison to the dust generated by other activities and natural processes. We assigned a stakeholder multiplication factor of 1.

In addition to addressing soil impacted by salt, all of the remedies call for the removal of about 4,000 square feet of caliche associated with the unused dirt road loop shown in Figure 1. We anticipate this caliche will be suitable for re-use at nearby roads or well locations and any dust generation created by the removal of caliche at the spill site is offset by the lack of dust created by a need to mine caliche elsewhere and transport it to a nearby location.

The footprint of the release is relatively small and the distance to pavement from the site is less than 1 mile; dust creation by any proposed remedy is relatively small. Therefore, we assigned a site multiplication factor of 1.

Exhaust Generation

The 65-mile haul distance to a landfill creates a relatively large exhaust impact to Remedy A so we assigned it a score of 1. Remedies B and E call for less transport and receive a score of 2. Remedies C and D generate about the same exhaust at the site due to excavation but not the exhaust caused by transport to a landfill. Remedy F requires earthworking equipment to condition the soil and will probably generate about the same mass of air pollution from engine exhaust as Remedies C and D. Remedies C, D and F received a score of 3.

Assigned Values for Exhaust Generation

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Weighted Value, Exhaust Generation
A	1	1	2	3
B	2			6
C	3			9
D	3			9
E	2			6
F	3			9

From a stakeholder perspective, air pollution and generation of greenhouse gas appears more important than dust generation at this site; creating a stakeholder multiplication factor of 2. The site multiplication factor is 1 for many of the same reasons discussed above for dust generation. The widespread use of closed loop/haul-off drilling in this area creates a large volume of exhaust that dwarfs any contribution from any remedy discussed herein.

Habitat Restoration

Native Vegetation

Over the long-term, reducing the disturbance footprint and transforming the area to natural vegetation (habitat and forage) is important and received a site multiplication factor of 3. With respect to the stakeholder importance, we assigned this criteria a multiplication factor of 3 – we believe all stakeholders desire restoration of the site to as close as practical to the pre-disturbance condition.

Remedies A and E are the most robust and have worked well at other sites. Therefore, these remedies are ranked higher than all others for this criterion. Because Remedy F relies upon natural precipitation plus some irrigation to flush the salt from the sandy soil, some maintenance and time are required for this remedy to succeed. In other areas where the soil contains more clay than this site, the addition of amendments to reduce salinity has failed. We assigned the lowest score for Remedy F, primarily due to the uncertainty of success. Remedies B, C, and D have a good chance of creating re-vegetation and we assigned a score of 2 for these remedies.

Assigned Values for Native Vegetation

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Weighted Value, Native Vegetation
A	3	3	3	18
B	2			12
C	2			12
D	2			12
E	3			18
F	1			6

Restore Original Landforms

The landforms in undisturbed areas appear are small dunes. Hall and Goble (2006, http://redrockgeological.com/pdf/2006_mescalero_sands.pdf) describe these dunes as coppice dunes that formed in the region after 1880 due to the northern expansion of Torrey Mesquite (see page 305 of the referenced publication). One can argue that the presence of mesquite and the coppice dunes is influenced by ranching and farming in the area. Replacement of dunes at this site is not considered a priority. In fact, one can argue that a remedy that removes mesquite and the accompanying dues creates an environmental benefit.

Remedies A-E call for borrowing topsoil from adjacent areas – which will cause mesquite/dune removal. Therefore all these remedies receive a score of 3. Remedy F calls for the creation of a small depression to capture precipitation during soil flushing/restoration but does not require removal of topsoil/mesquite from adjacent areas. Remedy F receives a score of 2. All remedies will foster the growth of native grass rather than mesquite and help return the area to "pre-Columbian" conditions.

Assigned Values for Restore Original Landforms

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Assigned Value, Restore Original Landforms
A	3	1	1	6
B	3			6
C	3			6
D	3			6
E	3			6
F	2			4

As described by Hall and Goble, the area of dune formation is enormous relative to the small area of the Arco Federal Battery impact. The site ranking multiplication factor is 1 as a result. Pending input from stakeholders about the importance of restoring the area to pre-1880 conditions, we assigned a stakeholder multiplication factor of 1.

Connectivity

Within the highly developed area of Loco Hills, creating large habitat corridors and/or a landscape with reasonable "connectivity" is very difficult in the short term. At the site, however, oil and gas development to the northwest and northeast is minimal and native landscape and relatively dense vegetation is present. Restoring the small area of the release footprint plus the "illegal" caliche road turn-out minimizes the habitat fragmentation between the northeast and northwest areas of undeveloped land to the width of the lease road – therefore we assigned a site multiplication factor of 2. Pending stakeholder input, we assigned a stakeholder multiplication factor of 2. As oil and gas activity in the area shuts down in 20-30 years, connectivity will become more important to stakeholders than today.

All remedies are ranked the same for this criterion because this scoring assumes that all remedies will be equally successful in restoring natural vegetation and soil in which animals can burrow. All of the remedies received a score of 2, a site multiplication factor of 2, a stakeholder multiplication factor of 2 and a weighted value for connectivity of 8.

Wildlife

The small area of the historic spill is not a critical habitat for wildlife and restoration of this small area will have little impact on wildlife, given the existing oil and gas development in the area. We assigned a site multiplication factor of 1 and a stakeholder multiplication factor of 1. By assuming that all remedies will succeed, all of the remedies are ranked equal 2 for the protection of wildlife, all receive a weighted value of 4.

Social Costs and Benefits

Allocation of Regulatory Review Time

As indicated above, Remedy F requires the most on-going maintenance and monitoring and will require more oversight than other remedies. Therefore this remedy receives the lowest score, 2. Although Remedies A and E are the most robust and Remedies B, C and D are familiar to the agencies – all of these remedies require some on-going monitoring and oversight by the agencies. These five remedies receive a score of 3.

Assigned Values for Regulatory Review

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Assigned Value, Regulatory Review Time
A	3	1	1	6
B	3			6
C	3			6
D	3			6
E	3			6
F	2			4

We assigned a multiplication factor of 1 for the site and a multiplication factor of 1 for stakeholder input because the small size of the impact.

Forage for Livestock and Multiple Use Access

The area of the historic spill footprint is small. During re-vegetation, the area may be fenced to prevent grazing and silt fences may be employed to minimize erosion. After 2 years, we believe vegetation can be re-established under all remedies. Therefore the site and stakeholder multiplication factors are both 1 and all remedies received the same score of 2, for a total value for forage of 4 for each remedy.

Impact on Resources

All of the remedies use fresh water for dust suppression during excavation. At the landfill, we assume that produced water or brine is employed for dust suppression. Remedy F relies upon the addition of a relatively small volume fresh water after large precipitation events to flush the salt below the root zone. However, Remedy F also calls

for the creation of a small depression to capture and hold precipitation, which may be considered a benefit. Because the amount of added water to enhance salt flushing is small, Remedy F receives the same score as all the other remedies, 2. Water is precious in the area of Loco Hills and we assigned a site multiplication factor of 3. Because stakeholders are accustomed to scarce water and the water used and/or saved by the remedies is small, the stakeholder multiplication factor is 1.

Assigned Values for Impact on Water Resources

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Assigned Value, Impact on Water Resources
A	2	3	1	8
B	2			8
C	2			8
D	2			8
E	2			8
F	2			8

The impact of each remedy to the environmental budget of the operator is also considered in this analysis, with a site multiplication factor of 3. This high multiplication factor is a function of the value of the land relative to the cost of the remedies. If, instead the impacted 1/3 acre were in suburban Dallas, the value of the land could be much more than the cost of any remedy and the site multiplication factor would be 1. With respect to the stakeholder multiplication factor, cost is generally not considered as a factor by government agencies – except for the evaluation of remedies under CERCLA. For the oil and gas operators who are also stakeholders, cost is very important. Nevertheless, we assigned a stakeholder multiplication factor of 1 because the requirements of a surface owner generally trump the wishes of a lessee. If a low-cost remedy can be successful and provide a high environmental benefit, the operator will be more willing to employ the low-cost remedy at other sites where environmental conditions warrant. Remedy A is the most expensive and receives the lowest score. Remedy F is the least expensive and receives a score of 3.

Assigned Values for Impact on Cost

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Assigned Value, Impact on Cost
A	1	3	1	4
B	1			4
C	2			8
D	2			8
E	2			8
F	3			12

Evaluation of cost in ranking environmental responses is not unique. Kealy and others (2001) consider cost in their NEBA analysis. Natural Resource Damage Assessments

determine the monetary value of environmental impacts. Habitat Equivalency Analysis is used to determine how much land a responsible party may purchase to offset the loss of habitat (ecological service). For a price of $35,000 (the lowest cost remedy) we believe the operator could purchase ten times the area of impact (i.e. 3 acres) at a location of nearby "sensitive habitat" selected by the current surface owner.

	Remedy A	Remedies B & E	Remedies C, D	Remedy F
Sq. ft.footprint of release(s)	10,500	10,500	10,500	10,500
Percent of footprint excavated	100%	40%	40%	30%
Ft. deep of 1000 ppm Cl	5	3	3	1
Total cubic feet of impact	52,500	31,500	31,500	10,500
ft3/yrd3	27	28	29	30
Total cubic yards of impacted soil	1,944	1,125	1,086	350
Expansion factor for soil	1.3	1.3	1.3	1.3
Cubic yards for transport	2,528	1,463	1,412	455
Yards/truck	20	21	0	0
Number of truckloads to landfill	126	70	0	0
Approx. cost/yrd excavation (remove and import soil)	$ 45.00	$ 45.00	$ 45.00	$ 45.00
Approx cost/yrd haul to landfill	$ 30.00	$ 30.00	$ -	$ -
Consulting and Analytical	$ 10,000.00	$ 15,000.00	$ 15,000.00	$ 20,000.00
Total Cost	**$ 173,333.33**	**$ 109,500.00**	**$ 63,879.31**	**$ 35,750.00**

Human Safety

All remedies require on-site earthwork and some vehicular transport. The safety threat posed by transport is greater than on-site earthwork as this element can involve the public. Remedy A requires the greatest amount of on-site earthwork and vehicular transport (waste to the landfill), we assigned it a score of 1. Remedies B and E require less earthwork and transport than Remedy A, and receive a score of 2. For Remedies C, D and F, the only vehicular transport involves moving equipment to and from the site. These three remedies involve about the same amount of on-site earthwork as B and E. A score of 3 was given to Remedies C, D and F. Human safety should be the most important factor; a multiplication factor of 3 is assigned for the site and stakeholders.

Assigned Values for Human Safety

Remedy	Score	Site Multiplication Factor	Stakeholder Multiplication Factor	Assigned Value, Human Safety
A	1	3	3	6
B	2			12
C	3			18
D	3			18
E	2			12
F	3			18

Summary

Table 3 presents the scoring of all remedies based upon the analysis presented above, listed from highest scoring to lowest. Remedy A and B are ranked relatively low and Remedies C, D and E rank highest.

Remedy	Total Score of all Weighted Values
C) Trench Burial	87
D)	87
E Mix On Acul	84
F	83
B) Long Removal	74
A)	69

HIGH = GOOD

This scoring represents the opinion of one professional and provides a starting point for creating a final NEBA, which is a collaborative effort between various stakeholders.