APPENDIX K

EROSION CALCULATIONS

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Erosion Calculations

Introduction

The primary effect of surface disturbances on soil resources is increased erosion and the resulting potential increase in sediment yield to nearby ephemeral drainages, perennial streams, and livestock ponds. Construction of proposed well pads would result in increased erosion of WTP Project Area soils in the short-term. Additional erosion may also be expected from construction of access roads, pipelines, and other project facilities. The increased erosion of soils could potentially lead to increased sedimentation in watercourses, siltation of ponds, and loss of vegetative cover, if Best Management Practices (BMPs) are not properly implemented.

Water Erosion Prediction Project (WEPP) Model

In order to estimate potential erosion and sediment yield increases from short-term and long-term surface disturbance, the Water Erosion Prediction Project model (WEPP) developed by the U.S. Forest Service was used (USFS 1999; USFS 2000). The WEPP model is a new generation of soil erosion prediction technology developed by the U.S. Departments of Agriculture and Interior over the past 15 years. WEPP is a process-based, distributed parameter, continuous simulation soil erosion model for use on personal computers, and can be applied to small watersheds and hill slope profiles within those watersheds. The physical processes that significantly affect erosion by water are represented, including climate prediction (precipitation, temperature, radiation, wind), infiltration, runoff, soil water evaporation/transpiration, plant growth, residue decomposition, soil water percolation, frost/thaw development, snowmelt, soil detachment by raindrops and flowing water, sediment transport, and sediment deposition.

Different erosion models have been developed in the past to estimate the rate of soil erosion from different land use practices, including the well-known Universal Soil Loss Equation (USLE) and Revised Universal Soil Loss Equation (RUSLE). WEPP was developed to overcome spatial and temporal limitations of the previous models, including USLE and RUSLE. WEPP uses steady-state sediment continuity equations to estimate soil erosion and deposition on a hill slope and adjacent watershed. Like all erosion prediction models, WEPP has certain limitations. WEPP is generally not suitable for modeling erosion from large watersheds. Several studies have found that WEPP consistently underestimates soil loss from topographically complex watersheds.

The WEPP software consists of the erosion prediction model, a climate generator program, and a set of Windows interfaces. The WEPP interfaces use a synthetic storm generator to estimate the average erosion rates from disturbed surfaces over a 30-year period. Custom climates were produced by the PRISM function of the model for five areas within the WTP Project Area (Cottonwood Ridge, Dry Creek, Harmon Canyon, Horse Bench, and Jack Creek) by interpolating between existing weather stations. Two model interfaces were used. Erosion from roads was modeled using the WEPP Road interface. The technical documentation for this interface is contained in EPA (1999). The input information to the WEPP Road interface includes: the road design (insloped, bare ditch; insloped, vegetated or rocked ditch; outsloped, rutted; or outsloped, unrutted); soil texture (loam, sandy loam, silt loam, or clay loam), and rock content (variable from 1 to 50 percent); road width and gradient; road segment length; road surface (native, graveled or paved); and traffic level (high or low). Erosion from the adjacent pipeline ROWs and other project facilities (well pads, compressor stations, airstrips, water management facilities, borrow pits, equipment storage areas, and temporary worker housing sites) was modeled using the Disturbed WEPP interface (EPA 2000). Disturbed WEPP estimates soil loss from disturbed forested surfaces. The input parameters include: gradients for the upper and lower portions of a hill slope; soil texture and rock content, as described above for WEPP Road; the type (twenty year-old forest, five year-old forest, shrubs, tall grass, short grass, low severity fire, high severity fire, or skid trail) and percent cover of vegetation; climate; and horizontal hill slope length.

Model Design and Assumptions

Erosion calculations were performed for the Proposed Action for two sub-areas of the WTP Project Area: 1) areas to the west and north of Horse Bench and Cottonwood Ridge that drain to Nine Mile Creek (the west sub-area), and 2) areas to the east and south of Horse Bench and Cottonwood Ridge that drain directly to the Green River (the east sub-area). Model runs were performed for short-term and long-term conditions. For Alternatives B-E, the modeled results for the Proposed Action were pro-rated according to the amount of surface disturbance associated with each alternative.

Calculations were made for the following features in each sub-area for the Proposed Action:

- Proposed co-located roads and pipelines,
- Proposed pipelines located along existing roads,
- Independent (cross-country) pipelines, and
- Well pads, compressor stations, airstrips, water management facilities, borrow pits, equipment storage areas, and temporary worker housing sites

Proposed Co-Located Roads and Pipelines

For the proposed co-located roads and pipelines, many of which are conceptual and may not be located exactly as shown on **Figure 2.2-1**, the total length of roads/pipeline within each soil type was calculated for each sub-area of the WTP Project Area. Erosion from the roads was modeled using the WEPP Road interface. Slope information for the soil types was used to estimate an average gradient for the roads that would be constructed or improved on each soil type. For roads located on soil types with slopes greater than 15 percent, an average gradient of 8 percent was assumed. For soil types with slopes of 1-8 percent, an average gradient of 4 percent was used, and an average gradient of 3 percent was used for soil map unit 50, the Haverdad loam. An average running surface width of 19 feet was assumed for all roads (a hybrid of primary roads that have an average width of 22 feet and secondary roads that have an average width of 16 feet). Traffic was assumed to be high for the short-term and low for the long-term. Road design, ditches, soil texture, rock content, and climate were assigned as described above for primary roads.

Disturbed WEPP was used to model the erosion from the co-located pipeline ROWs. The acreage of disturbance was calculated assuming that 80 feet of the total road/pipeline ROW of 100 feet would be disturbed during the installation of the pipelines.

The same gradient information as was used for the co-located roads was used to model the potential erosion from adjacent co-located pipelines. Hill slopes were modeled as twice the average gradient for the co-located road with a length of 100 feet. The vegetation was assumed to be short grasses with a 20 percent cover for the short-term (5-7 years) and 70 percent cover for the long-term. Soil texture, rock content, and climate were assigned as described above.

Proposed Pipelines along Existing Roads

Proposed pipelines that would be installed independent of new access roads were modeled separately using Disturbed WEPP. The acreage of disturbance was calculated assuming a 40-foot wide disturbed corridor. Other input factors were assigned as described above for the co-located pipelines.

Independent Pipelines

Independent (or cross-country) pipelines could total 10 miles under all alternatives, but the locations of these conceptual pipelines have not been determined. Therefore, the average erosion rate calculated for the other pipelines was used to estimate the erosion associated with these pipelines. The acreage of disturbance was calculated assuming a 40-foot wide disturbed corridor. Other input factors were assigned as described above for the co-located pipelines.

Well Pads, Compressor Stations, Airstrips, Water Management Facilities, Borrow Pits, Equipment Storage Areas, and Temporary Worker Housing Sites

Disturbed WEPP was used to model the potential erosion from well pads, compressor stations, airstrips, water management facilities, borrow pits, equipment storage areas, and temporary worker housing sites over the short-term (about 5 years) and long term. The total acreage of these facilities on each soil type was calculated for each sub-area of the WTP Project Area for the short-term and long-term. For these facilities, which are all graded to be flat, erosion is generated predominantly on the fill slopes. The amount of fill slopes increase for facilities constructed on sloped soils, and can range from about 5 percent of the total disturbed area to over 25 percent for facilities constructed on very steep slopes. For the purposes of this analysis, fill slopes were assumed to constitute 20 percent of the total disturbed area for these facilities. The fill slopes were assumed to be 2:1 (horizontal to vertical). Fill slope lengths were then calculated for average soil gradients of 4 percent (soil units 41, 50, 82, 107, and 123), 9 percent (soil unit 25), 13 percent (soil unit 14), 16 percent (soil unit 83), 24 percent (soil unit 5), and 30 percent (all other soil units). The calculated fill slope lengths range from 9 feet for an average soil gradient of 4 percent to 192 feet for an average soil gradient of 30 percent. The vegetation on the fill slopes was assumed to be short grasses with a 20 percent cover for the short-term (about 5 years) and 70 percent cover for the long-term. Soil texture and rock content were assigned as described above. The climate was selected according to the primary area where each soil type occurs in the WTP Project Area.

Improved and/or Rerouted Roads

For the Proposed Action and each alternative, roads which would be improved or rerouted were modeled separately from the other project facilities to evaluate the effect of improving the BLM system roads on the long-term and short-term erosion estimates. The average WEPP rate for each sub-area modeled for the co-located roads was used for the improved and rerouted roads, and was multiplied by the length of roads needing improvements or reroutes for each alternative. All improved and rerouted roads were assumed to have a running surface of 22 feet. It was assumed that roads constructed on gradients of up to 4 percent would have 3-foot wide ditches on both sides of the road, whereas those roads with average gradients greater than 4 percent would have a ditch only on the uphill side. The road design was assumed to be insloped with a vegetated or rocked ditch for all roads. Traffic was assumed to be high for both the short-term and long-term for all improved and rerouted roads.

Results

The results of the erosion modeling were used to evaluate the estimated increased erosion that would result from the development of the Proposed Action in watersheds that drain to Nine Mile Canyon and in watersheds that drain directly to the Green River.

Results for improved and rerouted roads, co-located roads and pipelines, other pipelines, and facilities that would be graded to be flat were summed together for each sub-area of the WTP Project Area for both the short-term and long-term. **Table K-1** below provides a summary of the estimated additional short-term and long-term erosion for each component and sub-area for the Proposed Action.

Table K-1. Summary of Erosion Calculations for the Proposed Action.

Project Component	Short-Term Erosion	Long-Term Erosion
Improved and Rerouted Roads - East	70	43
Improved and Rerouted Roads - West	17	10
Co-located roads and pipelines - East	443	209
Co-located roads and pipelines - West	1,113	553
Pipelines only - East	121	9
Pipelines only - West	322	26
Independent Pipelines - East	9	1
Independent Pipelines - West	19	2
Well pads, etc. – East[1]	121	9
Well pads, etc. - West[1]	322	26
Totals - East	**764**	**271**
Totals - West	**1,793**	**617**
TOTALS	**2,557**	**888**

All units in tons/year
[1]Includes erosion for proposed water management facilities, compressor stations, equipment storage areas, worker housing, airstrips, and pump stations

For Alternatives B, C, D, and E, the amount of additional erosion for co-located roads and pipelines, independent pipelines, well pads, and other project facilities was estimated by pro-rating the amount of surface disturbance under each alternative to the Proposed Action and applying this factor to the erosion estimates. For Alternative B, No Action, the short-term surface disturbance is 17 percent of that for the Proposed Action and the long-term disturbance is 15 percent of that for the Proposed Action. For Alternative C, Transportation Impact Reduction Alternative, the short-term surface disturbance is 99 percent of that for the Proposed Action and the long-term disturbance is also 99 percent of that for the Proposed Action. For Alternative D, Conservation Alternative, the short-term surface disturbance is 69 percent of that for the Proposed Action and the long-term disturbance is 66 percent of that for the Proposed Action. For Alternative E, Agency Preferred Alternative, the short-term surface disturbance is 91 percent of that for the Proposed Action and the long-term disturbance is 90 percent of that for the Proposed Action.

As previously mentioned above, improved and/or rerouted roads were modeled separately for each alternative as opposed to being a factor of the Proposed Action.

In addition, it should be noted, that under Alternative C, 19 miles of existing roads would be reclaimed, and under Alternative E, 17 miles of existing road would be reclaimed. Using the average erosion rates of 8.23 tons per mile for the east sub-area and 9.63 tons per mile for the west area, calculated from the results of the modeling conducted for the co-located roads and pipelines described above, and pro-rating the amount of roads in each sub-area, successful reclamation of these roads would result in the reduction in the additional long-term erosion of 49 tons per year for the east sub-area and 126 tons per year for the west sub-area under Alternative C, and 44 tons per year for the east area and 112 tons per year for the west sub-area for Alternative E. These amounts have been subtracted from the estimated total long-term erosion for these two alternatives.

Table K-2 below summarizes the total estimated increased erosion for the two sub-areas under each alternative.

Table K-2. Summary of Erosion Calculations by Alternative.

Alternative and Sub-area	Short-Term Erosion for roads, pipelines, and well pads[1]	Short-Term Erosion for Improved and Rerouted Roads	Long-Term Erosion for roads, pipelines, and well pads[1]	Long-Term Erosion for Improved and Rerouted Roads
Proposed Action - East	695	70	228	43
Proposed Action - West	1,776	17	606	10
Proposed Action Totals	**2,470**	**87**	**834**	**53**
No Action - East	126	15	35	9
No Action - West	317	17	93	10
No Action Totals	**443**	**32**	**128**	**19**
Transportation Reduction – East[2]	688	164	175	101
Transportation Reduction – West[3]	1,758	269	469	169

Table K-2. Summary of Erosion Calculations by Alternative.				
Alternative and Sub-area	**Short-Term Erosion for roads, pipelines, and well pads[1]**	**Short-Term Erosion for Improved and Rerouted Roads**	**Long-Term Erosion for roads, pipelines, and well pads[1]**	**Long-Term Erosion for Improved and Rerouted Roads**
Transportation Reduction Totals	**2,445**	**433**	**643**	**270**
Conservation - East	482	147	151	90
Conservation - West	1,231	186	401	116
Conservation Totals	**1,713**	**333**	**552**	**206**
Agency Preferred – East[4]	646	160	163	98
Agency Preferred – West[5]	1,602	243	439	153
Agency Preferred Totals	**2,248**	**403**	**602**	**251**

All units in tons/year
[1]Includes erosion for proposed water management facilities, compressor stations, equipment storage areas, worker housing, airstrips, and pump stations
[2]Includes a reduction of 49 tons per year due to reclamation of existing roads
[3]Includes a reduction of 126 tons per year due to reclamation of existing roads
[4]Includes a reduction of 49 tons per year due to reclamation of existing roads
[5]Includes a reduction of 126 tons per year due to reclamation of existing roads

These erosion estimates, as is the case for all erosion estimates, are subject to considerable uncertainty. Factors which contribute to the uncertainty include the exact location of the various facilities, the actual road and pipeline gradients, the effectiveness of BMPs, and climatic conditions. As such, these estimates should be considered to be accurate within the range of +/- 100 percent. However, because these estimates were made using the same set of assumptions, they provide a valuable way to compare the potential increased erosion that would result under the various alternatives.