DEPARTMENT OF ENVIRONMENTAL QUALITY
LAND QUALITY DIVISION

GUIDELINE NO. 9

ALLUVIAL VALLEY FLOORS
TABLE OF CONTENTS

INTRODUCTION .................................................................................. ii

I. DEFINITIONS .................................................................................. 1

II. IDENTIFICATION ............................................................................ 3

   A. Introduction ........................................................................... 3
   B. Identification of “Unconsolidated Stream Laid Deposits” .......... 4
   C. Identification of “Subirrigated or Flood Irrigation Agricultural Activities” ................................................................. 4
      1. Subirrigation Identification ............................................... 4
      2. Flood irrigation determination ......................................... 4
      3. Subirrigation or flood irrigation agricultural activities ......... 6
   D. Identification of Water Quality and Quality sufficient for flood Irrigation or Subirrigation Agricultural Activities ................. 6
      1. Subirrigation and natural flood irrigation ......................... 6
      2. Artificial flood irrigation water availability ....................... 6

III. EXTENT OF AN ALLUVIAL VALLEY FLOOR ................................ 7

   A. Aerial Extent ........................................................................... 7
   B. Depth ..................................................................................... 7

IV. IMPORTANCE OF ALLUVIAL VALLEY FLOORS TO FARMING ....... 7

   A. Introduction ........................................................................... 7
   B. Criteria for classifying alluvial valley floors as undeveloped rangeland ................................................................. 8
   C. Data used to determine the importance of developed land to a farm’s agricultural production ...................................... 8
   D. Importance of developed land to a farm’s agricultural production ................................................................. 9

V. MATERIAL DAMAGE ...................................................................... 10

   A. Introduction ........................................................................... 10
   B. Premining material damage assessment for alluvial valley floors containing lands of importance to farming ..................... 10
      1. Surface water ..................................................................... 10
      2. Groundwater ..................................................................... 11

VI. ESSENTIAL HYDROLOGIC FUNCTIONS ..................................... 13

   A. Introduction ........................................................................... 13
   B. Alluvial valley floor identification and studies ....................... 13
   C. Specific study suggestions ................................................... 16
      1. Erosion balance .................................................................. 16
      2. Surface water balance ....................................................... 17
      3. Alluvial saturated zone water balance ................................. 18
      4. Soil survey and analysis ................................................... 19
      5. Vegetation ......................................................................... 19

VII. MONITORING/MITIGATION DURING MINING AND RECLAMATION .... 19

TABLE 1 - CONVERSION FACTORS FOR VARIOUS FEEDS TO ANIMAL UNIT MONTHS (AUMS) .................................................................................. 20
INTRODUCTION

This document is a guideline only. Its contents are not to be interpreted by applicants, operators, or DEQ staff as mandatory. Its preparation is the result of numerous requests from coal applicants and operators, who have expressed a need for guidance to assist them in preparation of a comprehensive initial application containing all required information pertaining to alluvial valley floors.

The applicant should consult applicable Land Quality Division Coal Regulations to understand the basis of the recommendations of this Guideline. The information submitted must be sufficient to allow the regulatory authority to determine if an alluvial valley floor exists, identify the essential hydrological functions and determine if the alluvial valley floor is important to farming. Equally, the application must contain sufficient information to allow the assessment of material damage to water supplies on alluvial valley floors important to farming. The operator should work very closely with the regulatory authority well in advance of application submittal. This interaction will allow the operator to anticipate what the regulatory authority determinations may be and will allow him to develop acceptable mine and reclamation plans. The following pre-application submittal procedure is suggested:

1. Operator should develop rudimentary information on potential alluvial valley floors (reference, Parts II and III of the guideline and Chapter III, Section 2 (a) of the LQD Coal Regulations) both within the permit area and on adjacent lands.

2. After the above information has been developed on maps and aerial photos including a general description of where mining will occur, invite a representative of the regulatory authority to the field to get his opinion on what may be determined to be an alluvial valley floor, classification or potential alluvial valley floors with respect to developed or undeveloped lands, where a material damage assessment should be conducted and what information should be established to define the essential hydrologic functions.

3. Based upon the expressed opinions of the regulatory authority representative:
   a. Collect information and determine if any alluvial valley floor which occurs on affected lands may be prohibited from mining (see Part IV).
   b. Collect information and determine if any alluvial valley floors outside of the affected lands have developed lands of importance to farming (see Part IV) and if so collect information for a material damage assessment (see Part V).
   c. For alluvial valley floors on affected lands develop information whereby the regulatory authority can define the essential hydrologic functions.

4. Assuming that the area is not prohibited from mining, consult the regulatory authority with the findings of 3.b. and c. to establish what type of Mine and Reclamation Plans should be submitted.

5. If the results of 3.a. and b. above reveal that an operation may be prohibited from mining an alluvial
valley floor, consult the regulatory authority as to applicable procedures for a formal determination.

For additional discussion and guidance the Office of Surface Mining has a comparable guideline on Alluvial Valley Floors dated June 11, 1980.
I. DEFINITIONS

A. "Adjacent areas" Means land located outside the permit area upon which air, surface water, groundwater, fish, wildlife or other resources protected by the Act may reasonably be expected to be adversely impacted by mining or reclamation operations. Unless otherwise specified by the Administrator, this area shall be presumptively limited to lands within one-half mile of the proposed permit area (Land Quality Coal Regulations). Note: This guideline recommends outer limits for adjacent areas with respect to alluvial valley floor studies.

B. "Affected alluvial valley floor" As used in Part IV, those portions of an alluvial valley floor where use of the land for farming will be interrupted, discontinued or precluded by mine disturbance or where the essential hydrologic functions cannot be preserved during the mining operations.

C. "Affected land" The area of land from which overburden is removed or upon which overburden, development waste rock or refuse is deposited, or both, access roads, haul roads, mineral stockpiles, mill tailings, impoundments basins, and all other lands whose natural state has been or will be disturbed as a result of the operations (W.S. § 35-11-103(e)(xvi), May 1980).

D. "Alluvial saturated zone" Area or areas in which the void spaces are filled with water within unconsolidated stream laid deposits that may or may not be in communication with aquifers outside of these deposits.

E. "Alluvial valley floors" The unconsolidated stream laid deposits holding streams where water availability is sufficient for subirrigation or floor irrigation agricultural activities but does not include upland areas, which are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion deposits by unconfined runoff or slope wash, together with talus, other mass movement accumulation and windblown deposits (W.S. § 35-11-103(e)(xviii), May 1980).

F. "Animal-unit" One mature beef cow of approximately 1,000 pounds and a calf (up to 6 months old) (Land Quality Coal Regulations).

G. "Aquifer" A zone, stratum or group of strata that can store and transmit water in sufficient quantities for a specific use (Land Quality Coal Regulations).

H. "Capillary zone" Moist soil in direct communication with the water table by capillary action. This distance may be generally assumed to be 3 feet above the water table when field testing is not practical.

I. "Diversion" A channel, embankment, or other man-made structure constructed for the purpose of diverting water from one area to another (Land Quality Coal Regulations).

J. "Essential hydrologic functions" Those conditions of surface and groundwater hydrology that
support or enhance subirrigation or flood irrigation agricultural activities. These conditions include, but are not limited to, the erosional state of a stream, the surface water balance, the groundwater balance, the physical properties of the soils and substratum, and topographic configuration (Land Quality Coal Regulations).

K. "Farm" One or more land units on which agricultural activities are conducted. A farm is generally considered to be the combination of land units with acreage and boundaries in existence prior to August 3, 1977, or, if established after August 3, 1977, with those boundaries based on enhancement of the farm's agricultural productivity and not related to surface coal mining operations (Land Quality Coal Regulations).

L. "Flood irrigation" Irrigation through natural overflow or the diversion of high flows in which the surface of the soil is covered by a sheet of water. This includes:

1. Natural irrigation upon a strip of relatively horizontal land bordering a stream which is overtopped by the agriculturally useful flood, that is, a flood with 2 or 3 year recurrence interval.

2. Artificial irrigation with a reasonable diversion that transports natural streamflow by gravity to lands bordering a stream.

M. "Materially damage the quantity or quality of water" Changes in the quality or quantity or the water supply to any portion of an alluvial valley floor where such changes are caused by surface coal mining and reclamation operations and result in changes that significantly and adversely affect the composition, diversity, or productivity of vegetation or crops dependent on subirrigation and flood irrigation, or which result in changes that would limit the availability of water for flood irrigation of irrigable land existing prior to mining (Land Quality Coal Regulations).

N. "Subirrigation" The supplying of water to plants from underneath or from a semi-saturated subsurface zone where water is available for use by vegetation (Land Quality Coal Regulations).

O. "Subirrigation or flood irrigation agricultural activities" The past or present use of any tract of land for the production of animal or vegetable life, where the use is enhanced or facilitated by subirrigation or floor irrigation. These uses include, but are not limited to, the pasturing, grazing, and the cropping, cultivation, or harvesting of plants whose production is aided by the availability of water from subirrigation or floor irrigation. These uses do not include agricultural practices which do not benefit from the availability of water from subirrigation or flood irrigation (Land Quality Coal Regulations).

P. "Unconsolidated stream laid deposits" Earthen material transported and precipitated within a body of water flowing downslope along a definite path. Flood plains and terraces located in the lower portions of topographic valleys are generally composed of unconsolidated stream laid deposits (Land Quality Coal Regulations).
Q. "Undeveloped rangeland" Unimproved land whose use is generally limited to grazing of livestock. Undeveloped rangeland does not include areas within the alluvial valley floor where cultivated crops, small grains, and hay crops have been grown, the land has been improved by the introduction of certain vegetation for enhanced agricultural utility or native vegetation on the alluvial valley floor contributes substantially to the carrying capacity of a specifically controlled or managed grazing unit (Land Quality Coal Regulations).

R. "Upland areas" Those geomorphic features located outside the area of unconsolidated stream laid deposits and may include isolated higher terraces, alluvial fans, pediment surfaces, landslide deposits, and surfaces covered with residuum, mud flows, or debris flows, as well as highland areas underlain by bedrock and covered by residual weathered material or debris deposited by sheetwash, rillwash, or windblown material (Land Quality Coal Regulations).

II. IDENTIFICATION

A. Introduction

Some of the items below are generally necessary to support a positive identification of an alluvial valley floor. For certain site specific conditions, a negative declaration may be made by the regulatory authority if the information shows the absence of some of these items.

1. A stream is underlain by unconsolidated stream laid deposits.
2. Subirrigation or natural flood irrigation occurring on the stream laid deposits is of sufficient extent to provide for subirrigation of flood irrigation agricultural activities.
3. Artificial flood irrigation has been or is presently practiced on the valley bottom.
4. Water quantity and quality is sufficient and the stream laid deposits are conclusive to flood irrigation agricultural activities.

Procedures in Sections B, C, and D of this Part are suggested to aid in collecting information for identifying the items above. Procedures labeled with a single asterisk(*) should not require special equipment and may be used as a preliminary identification procedure. Certain small drainage bottoms may be initially eliminated from consideration when within the scope of Parts B, C, and they would not appear to be important to a farming operation. Two specific criteria which may be used to make this judgement include lack of a persistent active channel and stream laid deposits which are generally less than 50 feet in width. Use of other information may be used to eliminate larger sized drainage bottoms, however, as advised in the Introduction the applicant should consult with the regulatory authority to assure that he has not eliminated something that needs further consideration.
B. Identification of "Unconsolidated Stream Laid Deposits".

Most streams will be underlain by these deposits. The extent these deposits should be mapped should include a delineation of terraces which are the major identification factors. Positive identification may be assumed by observing:

*1. Channel bars, splays, abandoned meanders, modern flood plains or terraces at the site, or;

*2. Bedload or washload sediment deposited or transported in a nonbedrock channel bottom.

C. Identification of "Subirrigated or Flood Irrigation Agricultural Activities".

1. Subirrigation Identification.

Four criteria are recommended for identification of subirrigation. Color aerial photographs including color infrared taken in late summer are helpful as indicators of potential areas of subirrigation that may require further evaluation.

*a. Identification of significant amounts of subirrigated indicator plant species.

b. Identification of an alluvial saturated zone.

c. Identification of agriculturally useful plant roots:

(1) extending into the capillary zone or the water table,

(2) extending into a soil zone indicating reduced conditions by the presence of grey or blue mottles, or

d. Identification of a water table exhibiting diurnal fluctuations as a result of transpirational losses.

2. Flood irrigation determination

Flood irrigation identification may be divided into natural and artificial flood irrigation.

a. Natural flood irrigation may be determined by:

*(1) Identification of significant amounts of flood irrigated indicator plant species.
(2) Analysis of flood flow using recorded data and/or calculated data to determine floods of sufficient frequency to provide enhanced plant production.

(3) Extrapolation of flood flow data in (2) above on stream topography to determine the area inundated by agriculturally useful floods.

b. Artificial flood irrigation.

(1) Artificial flood irrigation may be determined by:

(a) Identifying existing artificial flood irrigation on stream laid deposits within and adjacent to the permit area. Existing artificial flood irrigation practices may be helpful while determining the potential for artificial flood irrigation on undeveloped areas.

(b) Evaluate the potential for artificial flood irrigation considering stream flow, water quality, soils and topography. The local conservation district may be consulted concerning the site potential for artificial flood irrigation as part of any analysis.

(2) Water availability

(a) Water availability may be evaluated per Part II.D.

(3) Procedures for determining existing and potential flood irrigation.

*(a) Identify streamside sites within the stream laid deposits that are topographically flat enough to artificially flood irrigate and have soils conducive to flood irrigation.

*(b) Examine water rights records, water diversion and transport structures associated with streams and valley bottoms within and adjacent to the permit area.

*(c) Document existing and historical artificial flood irrigation sites and practices on streams within and adjacent to the permit area.

*(d) Evaluate the potential for artificial flood irrigation considering (a), (b) and (c) above and water availability.
3. Subirrigation or flood irrigation agricultural activities.

Lands bordering streams and consisting of unconsolidated stream laid deposits are alluvial valley floors when "subirrigation or flood irrigation agricultural activities" exist. The potential for flood irrigation agricultural activities would also qualify these lands as an alluvial valley floor. Thus subirrigation or flood irrigation agricultural activities may include:

a. The presence of artificial flood irrigation or evidence that it has historically been practiced;
b. The presence of naturally flood irrigated or subirrigated areas from which crops have been harvested or are specially managed;
c. The presence of subirrigated or naturally flood irrigated areas of sufficient size and character to have the potential for development or special management; or
d. The presence of areas which have the potential for flood irrigation.

D. Identification of Water Quantity and Quality sufficient for Flood Irrigation or Subirrigation Agricultural Activities.

1. Subirrigation and natural flood irrigation.

Water quantity and quality are sufficient for subirrigation or natural flood irrigation agricultural activities if these irrigation activities are identified in II.C.1. and II.C.2.a. above.

2. Artificial flood irrigation water availability

a. Water quantity

(1) Determine the volume of water available for artificial flood irrigation.

(a) The mean annual flow should first be determined. The amount of this flow occurring during the growing season should be quantified.

(b) The volume of water from the two or three year flood should be determined.

(2) Identify an appropriate volume of water (such as a 2 acre-feet per acre) required to support certain artificial flood irrigation practices
common in the area of the proposed operation.

(3) Evaluate the efficiency of the artificial flood irrigation system.

(4) Compare (1), (2), and (3) above to determine water availability for artificial flood irrigation.

b. Water quality and its effect on soils

(1) Identify the water quality of flows occurring during a normal period of diversion or storage.

(2) Identify soil chemical and physical qualities.

(3) Evaluate long-term flood irrigation affects of soil quality and productivity.

III. EXTENT OF AN ALLUVIAL VALLEY FLOOR

A. Aerial Extent

The aerial extent of the alluvial valley floor will be that portion of the valley bottom consisting of unconsolidated stream laid deposits having or capable of supporting subirrigation or flood irrigation agricultural activities. The extent will not exceed the unconsolidated stream laid deposits as identified and mapped in Part II.B. These deposits will generally consist of terraces, flood plains and may include alluvial fans at tributary junctions with areas associated with the stream laid deposits of the stream in question. Artificial subirrigation is not generally considered to be part of an alluvial valley floor. However, in areas where it is unclear whether artificial subirrigation is the cause of increased plant productivity in the area, that area will be considered to be naturally subirrigated.

B. Depth

The depth of an alluvial valley floor is considered to be the depth of unconsolidated stream laid deposits under the area identified in A. above. The depth should be identified on perpendicular and longitudinal cross-sections of the valley bottom.

IV. IMPORTANCE OF ALLUVIAL VALLEY FLOORS TO FARMING

A. Introduction

Mining on alluvial valley floors if prohibited unless the affected alluvial valley floor is undeveloped rangeland which is not significant to farming, or if the land is developed it is of such small acreage that it would have a negligible impact on a farm's agricultural production. Section B. below provides criteria by which alluvial valley floors may be judged to be
undeveloped rangeland. Appropriate maps and data should be provided to affirmatively demonstrate that areas determined to be undeveloped rangeland will meet the criteria of Section B. If the alluvial valley floor does not qualify as undeveloped rangeland, such lands should be considered developed and the applicant should provide the data requested in Section C. so that the regulatory authority can determine the importance of the developed lands to a farm's agricultural production. Prior to conducting the assessment of Section B., the extent of the affected alluvial valley floor must be determined and the relationship of land uses (both historic and present) to the affected alluvial valley floor must be known.

B. Criteria for classifying alluvial valley floors as undeveloped rangeland

Undeveloped rangeland exists within an alluvial valley floor where no improvements to the land's productivity or management have occurred. Undeveloped rangelands would not include haylands, croplands and pasturelands where vegetative species have been introduced, or if native species exist, the alluvial valley floor has been fenced to take advantage of the greater productivity of the valley bottom. Lands classified as undeveloped rangelands are not significant to farm production.

C. Data used to determine the importance of developed land to a farm's agricultural production

Affected alluvial valley floors which do not qualify as undeveloped rangelands as defined in section B. below shall be considered developed land and the importance of these lands to a farm's operation determined. Information concerning developed lands should reflect changes in ownership/tenancy and management practices since August 3, 1977 and to the present. Where developed lands exist, the following information for the farm(s) which rely upon the developed land for support of their operation should be provided in the mine permit application.

1. Information for total farm production to include:
   
a. An inventory of typical livestock numbers.

   b. A cropland/hayland use summary for typical production and marketing years, including the following:
      
      (1) Acreage of each crop grown;
      
      (2) Yield per acre;
      
      (3) Total production harvested;
      
      (4) Estimated carrying capacity of aftermath (AUMs);
      
      (5) Disposition of the crops (percentage);
(a) Amount fed to farm's livestock; and
(b) Amount sold.

c. Acreage and estimated carrying capacity (AUMs) of the range and pasture resources of the farm under typical weather conditions, excluding crop production and carrying capacity of the crop aftermath.

2. Information for farm's developed lands within affected alluvial valley floor to include:

a. Information as requested in 1.b. and c. above;
b. A history of land uses and productions; and
c. Maps showing:
   (1) History of ownership/tenancy of the affected alluvial valley floor and adjacent lands.
   (2) History of land uses and management practices within and adjacent to the affected alluvial valley floor, e.g. fencing, irrigation structures, haylands, croplands, pasturelands, etc.
   (3) Extent of subirrigation.
   (4) Extent of affected alluvial valley floor.

Information requested in this section should be provided with an affidavit from the landowner/tenant.

D. Importance of developed land to a farm's agricultural production

Where developed lands are involved in a proposed mining operation and where agricultural use of such developed lands would be interrupted, discontinued or precluded during mining, the loss of such lands from farm's production capabilities must be assessed. If it is determined that the loss to farm production would only cause a negligible impact upon total production, then a permit to mine may be granted. The equation of:

\[ P = 3 + 0.0014X \]

Where:

- \( P \) = productive loss in percent.
- \( X \) = number of animal units in excess of 100.

is used to estimate allowable farm production loss less than 10 percent. "P" up to 10 percent is the percentage of productive loss considered to be of a negligible impact to a Wyoming
farm. The equation is a result of the following assumption: (1) that a 3 percent loss in production to a very small viable farming operation (100 AU’s) would constitute a production loss in excess of that which could be absorbed through management changes; and (2) that production loss which can be absorbed by viable farming operations will generally increase as total farm production increases. To utilize the equation all farm production must be converted to animal units. Any loss greater than 10 percent is considered to exceed a negligible impact to both small and large Wyoming farming operations. Table 1 attached to this guideline contains conversation factors for farm produce to AUM's.

V. MATERIAL DAMAGE

A. Introduction

1. Alluvial valley floors studies for possible material damage include both those that are within a permit area but will not be mined and those that are within adjacent areas. These areas must have developed lands which are important to farming to necessitate a material damage assessment.

2. Identification of areas to be studied.
   a. Identify aquifers affected by mining operations.
   b. Estimate the area of probable drawdown of those affected aquifers identified in 2.a. above.
   c. Pinpoint the affected aquifers identified in 2.a. above which are in hydraulic communication with the alluvial saturated zone within the area identified in 2.b. above.
   d. "Adjacent areas" are the areas identified in 2.c. and all alluvial valley floors downstream of any affected stream to its confluence with the next major tributary.
   e. Considering the results of d. above, evaluate these adjacent areas for potential alluvial valley floors having developed lands which are important to farming.

B. Premining material damage assessment for alluvial valley floors containing lands of importance to farming.

1. Surface water
   a. Surface water studies should include but not be limited to the following:
      (1) Changes in surface flow volume due to evaporate and/or
dewatering.

(2) Changes in surface water temperature.

(3) Changes in the baseline surface water quality normally supplied to the valley.

(4) Long-term interruption of surface water quality and quantity supplied to the alluvial valley after reclamation.

b. Specific studies

(1) Water balance

(a) Perform a reconnaissance baseline surface water balance.

(b) Compare (1)(a) above to the estimated surface water balance during mining and reclamation.

(c) Evaluate material damage to alluvial valley floors.

(2) Erosion analysis

(a) Determine baseline sediment load.

(b) Compare (2)(a) above to the estimated sediment load during mining and reclamation.

(c) Evaluate downstream material damage to alluvial valley floors.

(3) Water quality

(a) Determine baseline water quality.

(b) Compare (3)(a) above to the estimated water quality during mining reclamation.

(c) Evaluate downstream material damage to alluvial valley floors.

2. Groundwater
a. Groundwater studies should include but not be limited to the following:

(1) Changes in the volume of groundwater inflow to the alluvial valley floor.

(2) Changes in groundwater quality to the stream and the

(3) Long-term interruption of groundwater quality and quantity inflow to the alluvial valley floor after reclamation.

b. Specific studies

(1) Water balance

   (a) Perform a reconnaissance baseline groundwater balance.

   (b) Compare (1)(a) above to the groundwater balance during mining and reclamation.

   (c) Evaluate material damage to alluvial valley floors.

(2) Aquifer hydraulic properties and water quality.

   (a) Determine baseline water quality in the alluvial saturated zone.

   (b) Evaluate potential damage to aquifers within the adjacent area due to mining operations.

   (c) Using measured and predicted aquifer properties, generally model long-term and short-term changes in groundwater quality during mining and reclamation.

(3) Water Quality

   (a) Determine baseline water quality.

   (b) Compare (3)(a) above to the estimated water quality during mining and reclamation.

   (c) Evaluate downstream material damage to alluvial valley floors.

3. An analysis of anticipated changes to surface waters and groundwater that support alluvial valley floors should include consideration of the cumulative effect of all the
results of the studies of 1. and 2. above. This analysis should also include an estimation of the potential changes that may occur in productivity, soil conditions and availability of water to continue to support existing crops or plant communities. The assessment should demonstrate that any changes will not significantly alter the productive capability for the off-site alluvial valley floors.

VI. ESSENTIAL HYDROLOGIC FUNCTIONS

A. Introduction

1. Essential hydrologic functions of flood irrigation and subirrigation agricultural activities refer to the alluvial valley floor identified in "Part III, Extent of the Alluvial Valley Floor". If the alluvial valley floor is to be mined, studies are required to collect the data necessary to identify the functions so that they can be reestablished. If alluvial valley floors are located off-site, the essential hydrologic functions must be preserved.

2. Part VI.B. recognizes four cases of alluvial valley floors. Part VI.B. references specific studies in Part VI.C. that may be performed for each case to help identify essential hydrologic functions.

3. Part VI.C. contains a potpourri of specific studies to aid in identifying essential hydrologic functions. Specific studies are found under these general categories:
   a. Erosion balance;
   b. Surface water balance;
   c. Alluvial saturated zone balance;
   d. Soil Survey and analysis; and
   e. vegetation.

A suggested method of using this section would be to identify the case of alluvial valley floor using Section B., then proceed to the studies referenced in Section C.

B. Alluvial valley floor identification and studies

1. Description and identification procedures of alluvial valley categories.
   a. "Case W" alluvial valley floor:
      (1) Description and identification procedure.
(a) Streamflow is perennial.

b. "Case X" alluvial valley floor:
   (1) Description
      (a) Streams for which the alluvial saturated zone storage capacity is great enough to contribute to stream flow. The stream is dry at some periods of the year.
   (2) Identification procedure
      (a) Backhoe pit in alluvial material next to channel identifies an alluvial saturated zone.
      (b) Subirrigated vegetation appears nearly continuously down the channel length.
      (c) Hydrograph analysis or the comparison of alluvial water levels and stream stage identifies baseflow and interflow components.
      (d) Hydrograph analysis for baseflow identification.

c. "Case Y" alluvial valley floor:
   (1) Description
      (a) Upland channel transports water, and flood flow recharges the alluvial saturated zone. The capacity contributes, at most, only a few days of additional water to the channel.
   (2) Identification procedure
      (a) Backhoe pit in alluvial material next to the channel identifies an alluvial saturated zone.
      (b) Vegetation species identify only small, scattered, noncontinuous areas of subirrigation.

d. "Case Z" alluvial valley floor:
   (1) Description
(a) Upland channel acts only to transport water.

(2) Identification procedure

(a) Backhoe pit in alluvial material next to the channel shows no subirrigation or agriculturally useful plants from the alluvial saturated zone.

2. Specific studies suggested for alluvial valley floor cases identified in Section B.1.

Note: All studies referenced in this section refer to studies in Part VI.C. labeled with an asterisk(*) should be performed for all cases of alluvial valley floors.

a. "Case W" alluvial valley floor:

Study all asterisk(*) areas, plus:

(1) Section 1. a.(1), b.(1), d.(2), h.(1)

(2) Section 2. a.(1), a.(2), b.(1)

(3) Section 3. (all)

(4) Section 4. (all)

(5) Section 5. (all)

b. "Case X" alluvial valley floor:

Study all asterisk (*) areas, plus:

(1) Section 1. a.(1) b.(1), d.(2), e.(1), h.(1)

(2) Section 2. a.(1), a.(2), b.(1)

(3) Section 3. a.(1), b.(1), b.(3), d.(2), d.(3)

(4) Section 4. (all)

(5) Section 5. (all)

c. "Case Y" alluvial valley floor:

Study all asterisk(*) areas, plus:
(1) Section 1. a.(1), b.(1), e.(1)
(2) Section 2. a.(1), a.(2), b.(2)
(3) Section 3. a.(1), d.(2), d.(4)
(4) Section 4. (all)
(5) Section 5. (all)

d. "Case Z" alluvial valley floor:

Study all asterisk (*) areas, plus:

(1) Section 1. e.(1)
(2) Section 2. a.(3), b.(2)
(3) Section 3. (* areas)
(4) Section 4. (* areas)
(5) Section 5. (all)

C. Specific study suggestions

1. Erosion balance

   a. Identify the fluvial history and the present state of the stream.

      (1) To the extent practical map aggradational and degradational reaches of the stream within, upstream, and downstream of the permit area including consideration for man-made influences.

   b. Describe the longitudinal profile of the stream including depth to bedrock.

      (1) Discuss the map.

   c. Describe the existing channel, floodplain, and terrace profiles.

      *(1) Survey representative cross-sections at approximately 1500 foot intervals of the stream or to identify typical and atypical channel characteristics. Also a good definition of the active channel should be provided.
d. Identify the channel and floodplain texture, sediment load, size distribution, and bedforms if present.

*(1) Collect channel sediment samples, and separate bedload and washload fractions.

(2) Analyze the texture of the surface of the floodplain.

(3) Analyze sediment source and transport for different hydrologic flood events.

e. Identify vegetative stabilizers in the active channel.

(1) Estimate the quantity within the channel.

f. Identify channel and valley slope.

*(1) Map on an appropriate scale, 1" = 400'.

g. Determine existing meander properties.

*(1) Map on an appropriate scale, 1" = 400'.

*(2) Calculate sinuosity and other appropriate parameters.

h. Calculate stream velocity.

(1) Develop rating curves and estimate velocities using cross-sections identified in 1.c.(1) above at the estimated 2, 5, and 100 year flood.

2. Surface water balance

a. Collect streamflow records, taken upstream and downstream of the affected alluvial valley floor. This may encompass:

(1) Continuous recording gauges and records for one year.

(2) Hydrograph and hyetograph comparison for a storm event.

(3) Crest gauges read monthly for one year.

*(4) Discharge-volume-gauge analysis.

*(5) Monthly samples of water quality (reference LQD Guideline No. #8).
b. Collect streamflow records on tributaries affected or diverted by mining operations in the affected land. This may encompass:

(1) Continuous recording gauge records for one year.
(2) Crest gauges read monthly for one year.
*(3) Discharge-volume-gauge analysis.
*(4) Monthly samples of water quality including but not limited to temperature and total suspended solids (refer to LQD Guideline #8).

c. Collect precipitation and snowfall data and compare it to the hydrographs.

d. Analyze wind direction and snow transport in relation to the topography.

3. Alluvial saturated zone water balance

a. Identify configuration, location, and strata of the alluvial saturated zone; and develop geologic cross-sections.

(1) Use backhoe pits and strategically located drill holes and record geologic logs to bedrock.

b. Describe the connection of the alluvial saturated zone with adjacent confined or unconfined aquifers.

(1) Define the potentiometric surface(s).
(2) Perform pump tests to determine the range and distribution of aquifer properties.
(3) Identify faults or other hydraulic boundaries.

c. Identify specific lenses or perched water in the alluvial saturated zone.

*(1) Use backhoe pits and strategically located drill holes and record geologist logs at appropriate intervals.

d. Monitor subsurface groundwater in the alluvial saturated zone within, upstream and downstream of the permit area to adequately define the dynamic interrelationships of the system. This may encompass:
(1) Continuous recording gauges on piezometers and wells completed in the alluvial saturated zone on both sides of the stream for one year.

(2) Monthly readings on piezometers and wells completed in the alluvial saturated zone on both sides of the stream for one year.

(3) Monthly quality samples in the alluvial saturated zone (reference LQD Guideline #8).

(4) Quarterly quality samples in the alluvial saturated zone (reference LQD Guideline #8).

4. Soil survey and analysis

a. Perform a premining soil assessment.

*(1) Conduct a soil survey (reference LQD Guideline #1).

b. Determine soil suitability for flood irrigation.

*(1) Evaluate soil suitability (reference LQD Guideline #1).

c. Determine soil moisture characteristics and lithology.

(1) Evaluate and describe stream laid textural layers if present and describe both the potential and the actual moisture holding characteristics of each layer.

5. Vegetation.

*a. Perform a premining vegetation inventory providing special attention to varying vegetation patterns on terraces, subirrigated areas or cropped areas.

VII. MONITORING/MITIGATION DURING MINING AND RECLAMATION

Each permit should contain monitoring plans which provide sufficient information to show that the essential hydrologic functions of both "affected" and "unaffected" AVFs are being preserved or reestablished throughout mining and reclamation processes {ref: W.S. § 35-11-415(b)(x), Coal Rules and Regulations Ch. 5, Sec. 3(a), and Coal Rules and Regulations Ch. 5, Sec. 3(b)(ii)}.

AVFs which are in the process of being physically affected by mining (i.e., completely or significantly removed by excavation) need **not have** a monitoring plan. However, all "unaffected AVFs", including those AVFs which will be affected beyond the term of the current permit, located within or adjacent to the permit area **must have** specific monitoring and mitigation plans which show that the essential hydrologic function of such AVFs are being preserved {ref: Coal Rules and Regulations Ch. 5, Sec. 3(c)(II)}.

Once an affected AVF has been reestablished, a monitoring plan which shows the essential hydrologic function of the AVF must be included in the permit.
Monitoring plans should commit to annually gathering sufficient information (e.g., infrared aerial photography, annual surface photographic locations) to demonstrate that vegetation associated with the "unaffected AVFs" continue to grow to roughly the same extent as baseline and/or base year. Such monitoring should also provide sufficient information from alluvial groundwater wells and surface water monitoring stations to determine if the mining operations are adversely affecting the supply of water to "unaffected AVFs." This plan should include a description of the frequency and locations of monitoring.

Mitigation plans should commit the permittee to taking remedial actions, following consultation with LQD, if the monitoring information shows that the "unaffected AVFs" are being adversely impacted by mining operations. These actions will include all steps determined to be necessary to protect, restore and enhance important habitats to fish and wildlife, wetlands and riparian vegetation associated with the "unaffected AVFs" {ref: W.S. § 35-11-309(c), coal Rules and Regulations Ch. 2, Sec. 2(b)(vi)(B) and Coal Rules and Regulations Ch. 4, Sec. 2(r)(i)(C)}. 
## TABLE 1

CONVERSION FACTORS FOR VARIOUS FEEDS TO ANIMAL UNIT MONTHS (AUMS).

<table>
<thead>
<tr>
<th>Feeds</th>
<th>AUMS*/Tons (T) or Bushel (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As Fed Basis</td>
</tr>
<tr>
<td>Alfalfa hay**</td>
<td>3.35 (T)</td>
</tr>
<tr>
<td>Barley straw</td>
<td>2.26 (T)</td>
</tr>
<tr>
<td>Native hay</td>
<td>2.26 (T)</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>2.81 (T)</td>
</tr>
<tr>
<td>Corn silage</td>
<td>1.18 (T)</td>
</tr>
<tr>
<td>Protein Supple. &amp; Conc. ***</td>
<td>5.00 (T)</td>
</tr>
<tr>
<td>Barley (#2)</td>
<td>0.11 (B)</td>
</tr>
<tr>
<td>Corn (#2)</td>
<td>0.15 (B)</td>
</tr>
<tr>
<td>Oats (#2)</td>
<td>0.07 (B)</td>
</tr>
<tr>
<td>Rye (#2)</td>
<td>0.13 (B)</td>
</tr>
<tr>
<td>Wheat (#2)</td>
<td>0.15 (B)</td>
</tr>
</tbody>
</table>

*AUM = amount of forage required by a mature cow with calf or their equivalent for 1 month of grazing (Rangeland Management, Harold F. Heady, 1975).

**Adapted from Morrisons Feeds and Feeding, 21st edition.


All other values are from the Animal Science Division, Univ.

On a dry basis this would have a AUM value of 3.57 (T). 888e