Preliminary Draft

ASSUMPTIONS IN THE CROP SECTOR

A REVIEW

by

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The purpose of this paper is to elaborate on the basic assumptions that have been made or need to be made before the solutions for the 1985 RCA

This paper will state the regions to be used in the programming and and the assumptions used in the creation of the crop sector. It will examine technology and demands.

Regions

There are numerous sets of regions used in the programming models built for the 1985 RCA. These include data collection regions, crop producing regions, marketing and livestock producing regions, and range producing regions.

Data collection regions

There are several data collection regions used in the CARD/RCA programming models. The smallest collection regions used in this effort are counties. However, very little information is available at this level of aggregation. County data collected from the census and USDA's yields will be used.

The second set of regions used will be the Major Land Resource Areas (MLRAs) (Figure 1). Two sets of information will be used at this level of aggregation -- the 1982 National Resource Inventory (82NRI), and the information from Erosion Productivity Impact Calculator (EPIC). For the 1985 RCA, several adjustments have been made to the MLRAs. MLRAs 12, 58c, 60B, and 66 have been incorporated into 43, 58A, 54, 60A, and 64, respectively. In addition, MLRA 128 has been split into 128N and 128S,

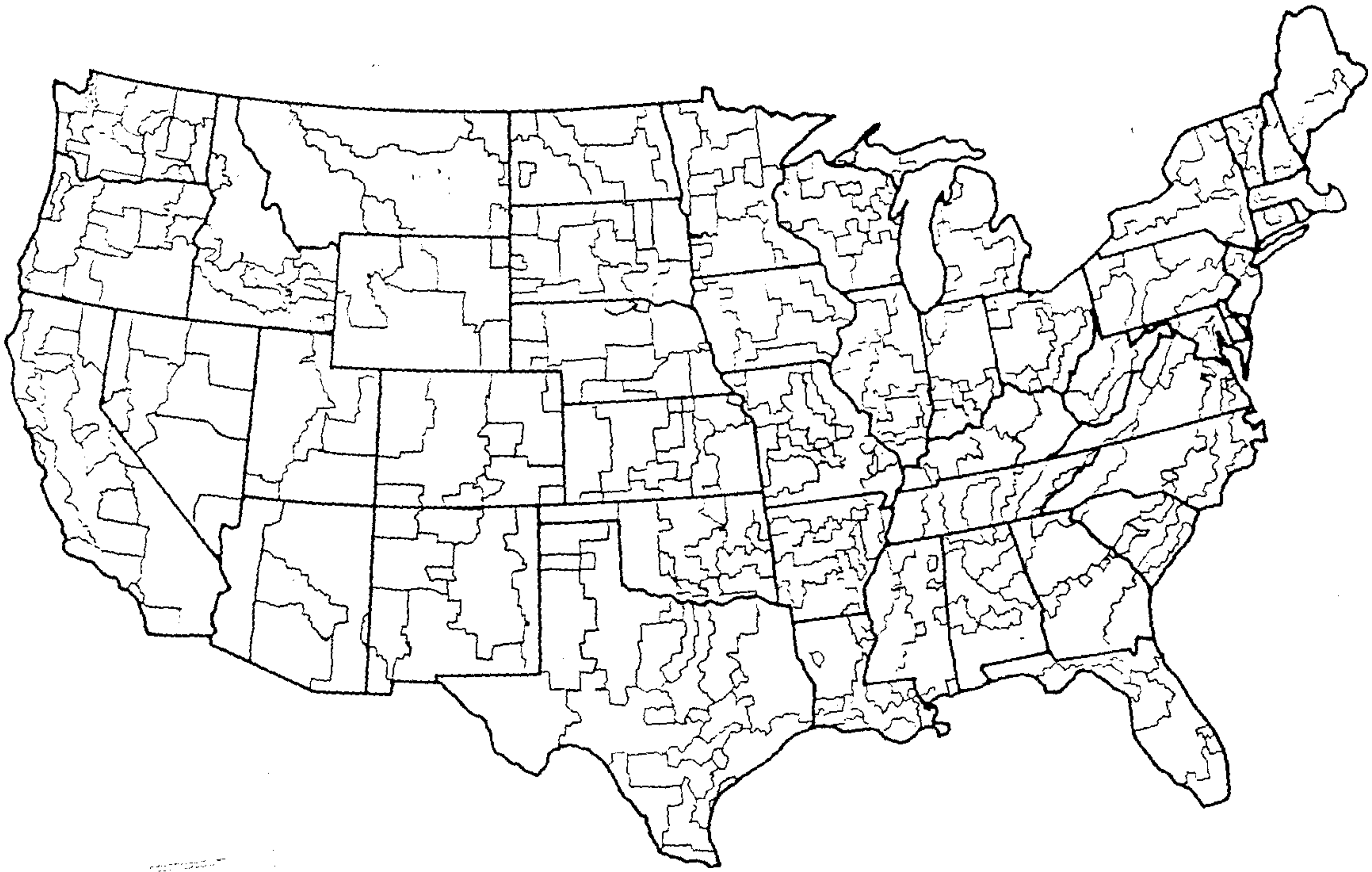

Figure 1. Major land resource areas with state boundaries

MLRA 135A has been split into 133N and 133S at the North/South Carolina border; MLRA 136 has been split into 136N and 136S at the North/South Carolina border, and the 153A has been split into 153N and 153S at the

The third set of data collection regions are the subareas developed by the Water Resources Council. Data from the Second National Water Assessment and from the 1978 Census are collected at this level of aggregation and used primarily in constructing the water Sector (Figure 2).

A fourth set of information is at the Bureau of Económic Analysis (BEA) aggregation level. These data provide information for the methodology used in determining nonagricultural land demands as well as population. The population data are used in distributing per capita commodity demands.

The fifth set of regions used is the Forest Service's potential natural communities (PNC). The data on the range sector are based on these regions. These data will be aggregated to the Ecosystem level.

The final set of information will come from state data.

Crop producing regions

The model will contain 105 producing areas (PA) which are the same as the 99 aggregated subareas (ASA) of the U.S. Water Resources Council, except six ASAs are subdivided (Figure 3). Crop producing activities and water supply activities will be built for these regions.

Marketing and livestock producing regions

The 105 PAs are aggregated into 31 market regions which serve as the smallest breakdown for the commodity demands, transport linkages, and livestock production and input purchasing activities (Figure 4).

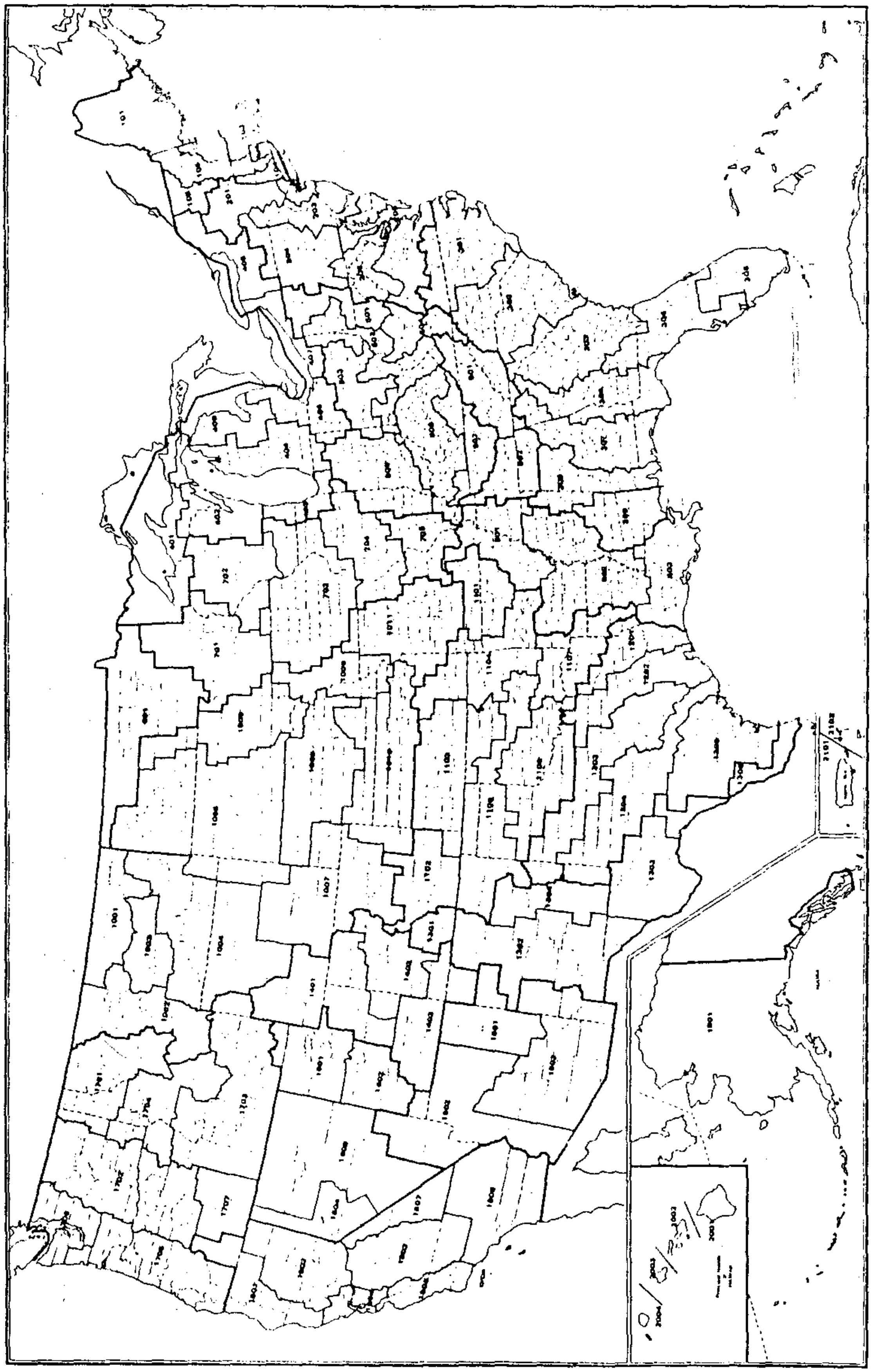

Figure 7. Assessment Subareas
(county approximations of assessment subregions)

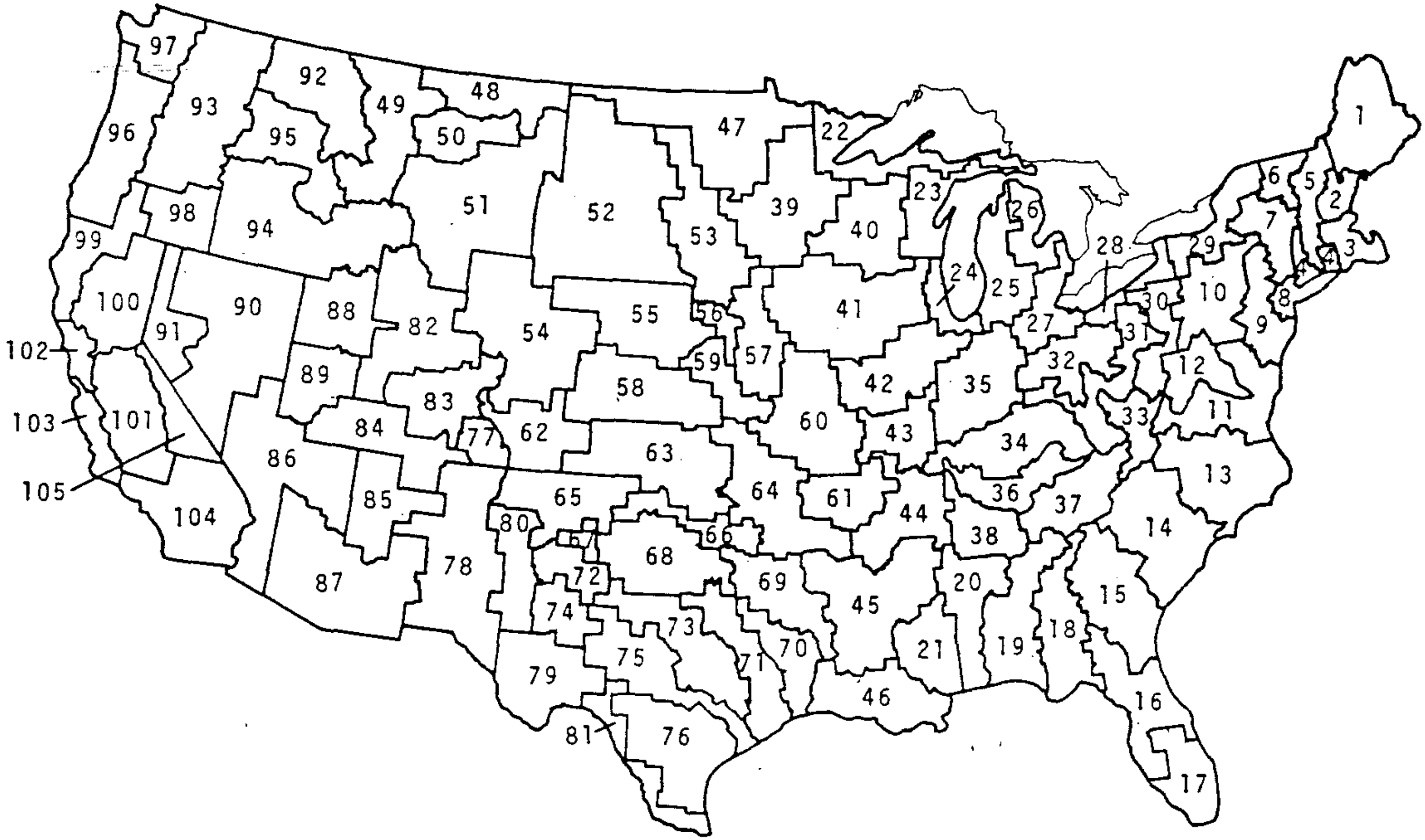

Figure 3. The 105 Producing Areas

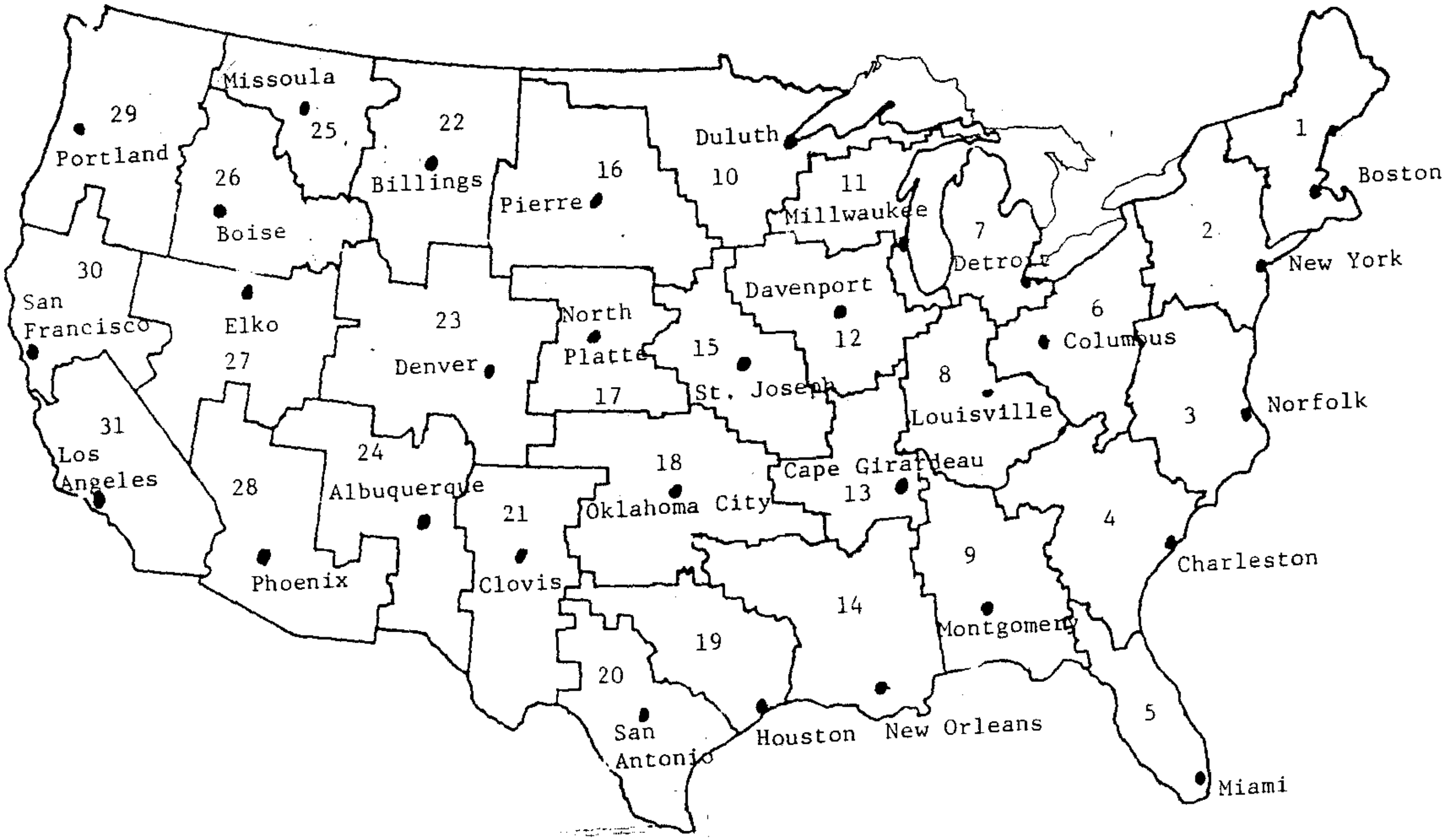

Figure 4. The 31 market regions

Range forest regions

Range and forest activities will be based on the 34 ecosystems referred to earlier.

Major Assumptions in Creation of the Crop and Livestock Sectors

Crop

Before examining the assumptions required to construct a crop sector, some terms must be defined.

1. Rotation is defined as a sequence of crops.
2. Conservation practices include straight row, contour, strip crop, and terracing. It is assumed that strip cropping cannot occur unless at least 25 percent of a rotation is in hay. In addition, it is assumed that terraces are built on the contour.
3. Tillage practices incorporate fall plow, spring plow, reduced tillage, and no-till. Reduced tillage is defined as a tillage practice leaving some residue on the ground year around.
4. The eight land groups are defined as aggregations of the Land Capability Class/Subclass system. The aggregations are shown in Table 1.
5. Cropping practice is defined as a single combination of rotation, conservation practice, and tillage practice on a given land group. Thus, an example of cropping practice would be 50 percent corn, 50 percent soybeans, using conventional reduced tillage conservation/tillage practice in Land Group I.

Endogenous crops that are included in the 1985 CARD/RCA model will be barley, corn, corn silage, cotton, legume hay, nonlegume hay, oats, pasture/range, peanuts, sorghum, sorghum silage, soybeans, sunflowers, and winter and spring wheat. These crops, along with the corresponding crop code numbers, are presented in Table 2. Double cropping will also be included in the programming model.

There are two basic files that EPIC requires from CARD. These files are the rotation file and the machinery complement and input file.

Rotation File:

The constitution of the rotation file was initiated several years ago by contacting the state SCS offices for their C-factor rotation files. From these files, a data set was constructed with over 11,000 records. Using this file and some supplemental rotations from the Applied Conservation Effects questionnaire, a rotation file was developed. The goal in creating this file was to maintain adequate crop coverage while keeping the rotation file to a manageable size. To achieve this, a set of rules was developed and are presented in Table 3.

As you will notice from these rules, we have not adequately examined sunflower rotations nor double cropped rotations. It is assumed or previously recommended by PAC to grow sunflowers in the Dakotas and Minnesota but not in other regions of the United States.

This file was verified by an agronomist located at each of the Soil Conservation Services' National Technical Center. Additional rotations were added to the file and some stricken from the file based on their recommendations.

Table 2. Rotation file crop codes

Crop code	Crop Definition
1.	Barley
2.	Corn
3.	Corn Silage
4.	Cotton
5.	Legume Hay Harvest
7.	Oats
8.	Pasture
9.	Peanuts
10.	Sorghum
11.	Sorghum Silage
12.	Soybeans
13.	Summer Fallow
14.	Sunflowers
15.	Spring Wheat
16.	Winter Wheat
17.	Establish Legume Hay
18.	Establish Non-legume Hay [a]
81.	Winter Wheat - Soybeans DC
82.	Non-legume Hay - Winter Wheat DC
83.	Sorghum - Winter Wheat DC
84.	Corn - Sunflowers DC
85.	Corn - Sorghum DC
86.	Sorghum - Soybeans DC
87.	Corn - Soybeans DC
88.	Wheat - Peanuts DC
89.	Sorghum - Oats DC
90.	Oats - Soybeans DC
91.	Oats - Peanuts DC
92.	Barley - Soybeans DC
93.	Barley - Corn Silage DC
94.	Winter Wheat - Corn Silage DC
95.	Barley - Sorghum DC
96.	Barley - Corn DC

[a] DC indicates double cropping (two crops in one year). The crop sequence is as expressed in the table.

Table 3. Rotation selection rules

1. Continuous rotations for HLH and NLH shall be included in all MLRAs.

2. If over 20 percent of the acreage in a given PA is in a single crop, then a continuous crop rotation for that crop is to be included in the MLRA.

3. At this point, keep all double cropping rotations.

4. Eliminate all rotations with winter cover. If winter cover is desired, it will be treated as a different conservation practice.

5. If more than 1 percent of the acreage within a given MLRA is planted in a given crop, then that crop must appear in 3 or more rotations.

6. All sunflower rotations are to be kept.

7. All minor crops (minor to a MLRA is defined as less than 1 percent) shall be represented in at least one rotation. However, if it is less than .05 percent, then it is assumed not to exist.

8. If a rotation is greater than 6 years, then it is not included.

9. If a rotation is greater than 5 years and has 4 years of contiguous crop, then it is not included. Example: corn, corn, hay, hay, hay, hay.

10. Keep the number of rotations below 20 rotations in a given MLRA. Do not count double crop or sunflower rotations at this point.

This file was then converted to a PA file by assigning MLRAS to PAs (Appendix A). This file was then checked based on the criteria presented in Table 3.

Machinery complement and other input file:

Crop and tillage practice machinery complements and input requirements were obtained from the SCS state offices. These complements were placed on a state based computerized data set. Once coded, these budgets were assigned to the RCA MLRAs and sent back to the states for review.

After the first review, the budgets were then sent to the National Technical Centers so that missing budgets (based on the needs of the MRLA rotation file) could be built. During this check, consistency between tillage practices was also conducted using the definitions in Table 4 and mixing efficiencies described in Table 5. The Technical Centers' personnel

Table 4. Tillage definitions used in the RCA analysis

Tillage practices	Definition
No till	More than 70 percent residue cover after planting
Conservation Tillage	Between 70 and 30 percent residue cover after planting
Conventional Tillage	Less than 30 percent residue cover after planting

then examined those budgets that did not meet the tillage definition. They adjusted the tillage complement so that the definition would be met, or in some cases the mixing efficiency was altered to reflect present farming practices.[1]

[1]The mixing efficiency assumed in Table 5 represents a maximum mixing efficiency. Since the objective of conservation tillage is to leave some residue on the ground, equipment could be adjusted so that the efficiency was reduced.

Table 5. Mixing efficiencies assumed in estimating residue incorporation

Equipment	Mixing efficiency
	----percent-----
Tandem disk	.500
Offset disk	.600
Oneway disk	.700
Moldboard plow	.900
Chisel plow	.400
Subsoiler	.300
Bedder/lister	.800
Field cultivator	.400
Row crop cultivator	.500
Harrow-springtooth	.200
Harrow-spike	.200
Rotary hoe	.100
Seed bed conditioner	.100
Roller harrow	.050
Culti-Packer	.050
Tandem packer	.050
Stubble mulcher	.100
Rodweeder	.050
Anhy Appl	.150
Drill	.250
No till drill	.100
Cultipack seeded	.050
Sandfighter	.100
Boarder Disk	.600
Furrower	.200
Row planter	.050
Min-till planter	.150
Lister planter	.800
Rock picker	.150

Table 5 (continued

Equipment	Mixing efficiency
Landplane	.500
Scraper	.500
Roto-tiller	.600
Ditcher	.050
Peanut digger	.500
Oneway disk	.700
Moldboard plow	.900
Bedder/lister	.800
Chisel plow	.400
Subsoiler	.300
Tandem disk	.500
Offset disk	.600
Field cultivator	.400
Roto-tiller	.600
Harrow-springtooth	.200
Harrow-spike	.200
Seed bed conditioner	.100
Roller harrow	.050
Culti-packer	.050
Tandem packer .050	
Stubble mulcher	.100
Rodweeder	.050
Sandfighter	.100
Boarder disk	.600
Furrower	.200
Rock picker	.150
Landplane	.500
Scraper	.500
Ditcher	.050
Row crop cultivator	.500

Table 5 (continued)

Equipment	Mixing efficiency
Rotary hoe	.100
Anhy appl	.150
Peanut digger	.500
Drill	.250
No till drill	.100
Cultipack seeder	.050
Row planter	.050
Min-till planter	.150
Lister planter	.800

Data requirements for yield sector:

One of the most important data sets in the Center for Agricultural and Rural Development, Soil and Water Resources Conservation Act's family of models (CARD/RCA) is the crop sector. The crop sector requires information on yields,* nitrogen,* phosphorus,* potassium,* and energy use (electricity, diesel, natural gas, and LPG); irrigation water requirements;* soil erosion* (water and wind); and costs of production.[1] Information for the items with an * can, for the most part, be derived from EPIC. This portion of the paper addresses the transformations required to use EPIC output information as input information in the CARD/RCA crop sector models.

EPIC can be defined as a sophisticated production function that incorporates numerous algebric submodels which interact to simulate the values of many input and output variables of the plant growth process.[2] (Table 6). By matching these variables to those needed by the CARD/RCA models, an information flow between EPIC and CARD/RCA can be established. The linkage of data items is presented in Table 7.

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[1] In this paper, costs of production are defined as costs other than the costs accounted for by the endogenous variables.

[2] The EPIC will be run using the following assumptions:

1. An automatic fertilizer test will be conducted just after planting the crop. The soil test indicates the quantities of N and P that EPIC will apply to meet the crop's nutrient demands given the condition of the soil. One additional side dressing is applied to the field if needed.
2. Technology will be held constant in the EPIC runs. It is, therefore, assumed that a change in technology will not significantly affect the residue left on the ground.
3. A weather seed will be selected, such that no bias in yields (resulting from weather) exist over time. To find this seed, a linear regression will be performed with rainfall as the dependent variable.

$$R = a + bt$$

Table 6. Output variables from EPIC (The units of measurement are in parentheses)

AOF = Soil loss - Onstad-Foster estimate (T/HA)
C = Average USLE C factor
CAN = Crop available N (KG/HA)
CAW = Crop available water (MM)
CN = Average SCS runoff curve number
CROP = Crop name
DM = Total plant biomass (KG/HA)
DN = Denitrification (KG/HA)
DNS = Days of nitrogen stress (#)
DPS = Days of phosphorus stress (#)
DTS = Days of temperature stress (#)
DWS = Days of water stress (#)
EI = Rainfall energy factor (T/HA*H)
EP = Actual plant evaporation (MM)
ER = Enrichment ratio (nitrogen and phosphorus) (kg/HA)
ERTH = Eroded thickness (MM)
ET = Actual evapotranspiration (MM)
EVN = NO3 upward movement from soil evaporation (KG/HA)
FN = Average annual N fertilizer rate (KG/HA)
FON = Fresh organic N (KG/HA)
FP = Average annual P fertilizer rate (KG/HA)
HRLT = Average daily light duration (H)
HU = Accumulated heat units (C)
HUM = Humus (T/HA)
IM = Immobilization
IMN = N immobilized (KG/HA)
IMP = P immobilized (KG/HA)
IRGA = Irrigation water applied (MM)
LAI = Leaf area index
MN = Mineralization
MNN = N mineralized (KG/HA)
MNP = P mineralized (KG/HA)

Table 6. (cont.)

NFIX	=	Nitrogen fixation (KG/HA)
PEP	=	Potential plant evaporation
PET	=	Potential evapotranspiration
PLAB	=	Labile P present in soil profile (KG/HA)
PNS	=	Percent of nitrogen stress (%)
PPS	=	Percent of phosphorus stress (%)
PRK	=	Percolation (MM)
PRKN	=	NO3 loss in percolate (KG/HA)
PTS	=	Percent of temperature stress (%)
PWS	=	Percent of water stress (%)
Q	=	Surface runoff (MM)
RAD	=	Average solar radiation (C)
RAIN	=	Rainfall (MM)
RD	=	Root depth (MM)
RN	=	Nitrogen in rainfall (KG/HA)
RSD	=	Crop residue (KG/HA)
RTWT	=	Root weight (MG)
SNOW	=	Water content of snow (MM)
SSO3	=	Leached NO3
SSF	=	Subsurface flow (MM)
SSFN	=	NO3 loss in subsurface flow (KG/HA)
SW	=	Total soil water in profile (MM)
TMN	=	Average minimum temperature (C)
TMP	=	Average temperature in third soil layer (C)
TMX	=	Average maximum temperature (C)
TNO3	=	NO3 present in soil profile (KG/HA)
UNO3	=	N uptake by crop (KG/HA)
UPP	=	P uptake by crop (KG/HA)
USLE	=	Soil loss - USLE estimate (T/HA)
WDIR	=	Average wind direction (clockwise RAD from N)
WVL	=	Average wind velocity (M/S)
Y	=	Soil loss - MUSLE estimate (T/HA)

Table 6. (cont.)

YAP	=	Soluble P loss (KG/HA)
YEAR	=	Year of simulation (yr.)
YLD	=	Crop yield (KG/HA)
YN	=	Yield organic nitrogen (?)
YNO3	=	NO3 loss in surface runoff (KG/HA)
YON	=	Organic N loss with sediment (KG/HA)
YP	=	P loss with sediment (KG/HA)
YPA	=	Available phosphorus (')
YW	=	Soil loss from wind erosion (T/HA)

Table 7. Data needs in the crop sector of the CARD/RCA model family and the source to be used in filling these needs

Crop sector variables	Variable from EPIC	Other Sources
Rotation	CROP	
Yields	YLD[a], DM	
Fertilizers:		
N	FN[a] UNO3	
P	FP[a] UPP	
K		FEDs[b]
Energy Use:		
Diesel		FEDs
Electricity		FEDs
Natural gas		FEDs
LPG		FEDs
Soil loss:		
USLE	USLE[a]	
Other water	AOF[ac], Y[ac], ERTH, Q	
Wind	YW[a]	
Costs		FEDs
Residue	RSD	

[a]This is the variable to be used or transformed in the CARD model. The other variables will be carried along for future analysis.

[b]Firm Enterprise Data System

[c]If one of these two variables is selected as the soil erosion driver, it will be used in the LP and the USLE will be carried along.

The yield data derived from EPIC consist of four yield adjustments (Putman, Dyke, 1985). A yield index is provided for each crop by RCA land group in each MLRA (Table 8). This yield index is adjusted, based on the crop previously produced, on the tillage practice, and on the amount of erosion that has occurred.[1] Therefore, a unique yield exists for each crop year within the cropping practice.

Since the data described above incorporates yield indexes and not actual yields, MLRA yields are derived from the Statistical Research Service's county data base. Average county yields are derived over the years 1979, 1980, and 1981 and aggregated to MLRA.

An example of the steps involved in this is shown below for MLRA 109. Assume that the cropping practice is a corn, corn, soybeans rotation on the land employing reduced tillage and strip cropping. To estimate the yield for this cropping practice, seven items are required:

1. Yield index for all RCA land group in the MLRA;
2. Land in corn and soybeans in MLRA 109 by land group;
3. Average yield for both corn and soybeans;
4. Tillage yield adjustment for both corn and soybeans;
5. Crop sequence yield adjustment for corn following corn, corn following soybeans, and soybeans following corn;
6. Yield adjustment due to erosion;
7. The amount of accumulated erosion.

Items 1 and 2 are presented in Table 8. By multiplying the yield index by quantity of land in corn in each land group, a proxy for

[1] No adjustment for conservation practice is made.

Table 8. Corn and soybean yield indexes and quantity of land by land group for MLRA 109

RCA land group	Corn yield index	Quantity of land in corn (acres)	Proxy production (index & acres)	Adjusted corn yield index	Soybean yield index	Quantity of land in soybeans (acres)	Proxy production (index & acres)	Adjusted soybeans yield index
1	1.0483	281.4	295.0	1.1213	1.0596	421.8	446.9	1.1428
2	1.0000	169.6	169.6	1.0697	1.0000	241.2	241.2	1.0786
3	0.8082	435.3	351.8	0.8645	0.7877	659.8	519.7	0.8496
4	0.8830	143.3	126.5	0.9413	0.8927	129.4	115.5	0.9628
5	NA	NA	NA	NA	NA	0.0	0.0	NA
6	0.7500	7.5	5.6	0.8022	0.7500	10.0	7.5	0.8089
7	1.0500	219.90	230.9	1.1231	1.0500	223.10	234.3	1.1325
8	6.8680	63.7	55.3	0.9285	0.8487	49.3	43.1	0.9434
Total		1320.7	1234.7			1734.6	1608.3	

[a]Proxy yields

$$\frac{1320.7}{1234.7} = 1.06965$$

$$\frac{1734.6}{1608.3} = 1.07856$$

production is determined. When this is summed over the eight land groups and divided by acres, the result should equal one. If the result is less than one, the yield index is too low. In Table 7, the third and seventh columns illustrate the proxy "production" calculations with the adjusted corn and soybean indexes illustrated in columns 4 and 8. These indexes provide a base corn/soybean yield for a given land group. Assuming 89 and 27 bushels per acre corn and soybean yield per acre, respectively, the corn (soybean) base yield for Land Group 4 (IVe) is 83.8 (26.0) bushels per acre.

The next step is to adjust for crop sequence. Using a corn, corn, soybeans rotation, three different crop sequences can be specified: corn after corn, soybeans after corn, and corn after soybeans. Utilizing the information in Table 9, we find yield for these three sequences to be:

for corn after corn	83.8 times 1.1306 = 94.7;
for soybeans after corn	26 times 1.041 = 27.1; and
for corn after soybeans	83.8 times 1.0219 = 85.6.

Therefore, an acre of land in this rotation with 2/3 corn and 1/3 soybeans would yield 60.1 bushels of corn and 9 bushels of soybeans.

The final adjustment is attributed to the tillage practice employed. In an example, a conservation tillage practice is assumed. Under this practice, corn yield is reduced by multiplying 60.1 bushels of corn by 0.9988, a reduction of 0.1 bushels (Table 10 soybean yield on the acre of land is also approximately 0.1 bushels.

The next step is to adjust for future yields. The first step is to increment the 1980 yields upward because of the estimated technology impacts. From Table 11, the projected yield for corn in the year 2030 is assumed to be 40 percent above the 1980 level and for soybeans, 60

Table 9. Yield adjustments for crop sequences, including corn and soybeans for MLRA 109

Crop sequence	Yield adjustment
Corn after corn	1.1306
Corn after legume hay	1.0486
Corn after grass hay	1.0626
Corn after soybeans	1.0219
Corn after wheat	1.0000
Soybeans after corn	1.0410
Soybeans after soybeans	1.0000

Table 10. Tillage adjustment for corn and soybean yields for MLRA 109

Tillage practice	Corn	Soybeans
No winter cover	1.0117	0.9978
Winter cover	1.0000	1.0000
Conservation tillage	0.9988	0.9886
No-tillage	0.9924	0.9851

Table 11. Projected yields assumed in the 1985 RCA analysis

Crop	2000	2030
	-------percent-------	
Feed grains	40	100
Hay	20	50
Wheat[a]	50	100
Cotton[b]	50	50
Soybeans	60	120

[a]Farm production regions (Southern Plains, Northern Plains, and Mountain) will have yield gains 10 percent below the national gain in in yields by 2000 and 20 percent below by 2030.

[b]Cotton yield projection for the San Joaquin Valley and the Pacific Region are 10 percent higher than the national levels.

percent higher. Therefore, the base yield on 2030 will be 120.2 bushels of corn on 2/3 of an acre (180 bu./acre) and 19.6 bushels of soybeans on the remaining 1/3 of an acre (59 bu./acre).

The last adjustment to yields because of erosion must now be made. The first step in this process is to determine the erosion levels. From Table 12, we find the levels of erosion for strip cropping using conservation tillage methods. Again, for each of the three crop sequences the values are reported in Table 13.

Accumulating the tons lost over 50 years for corn after soybeans, 1,119.0 tons of soil or approximately 7 inches of top soil is lost over the 50 year period. The next step is to use this accumulated soil lost in estimating the erosion impact. As reported from regression models developed at Temple, Texas by Putman, Dyke, and Wistrand (1984),

Table 12. Erosion level[a] on 4e land (Land Group 4) in MLRA 109 for selected crop sequences by conservation and tillage practice

Crop sequence	Straight row	Contour	Strip cropping	Terracing
	tonnes per hectare			
Corn after corn:				
No winter cover	60.78	60.78[b]	36.47	35.71
Winter cover	42.82	42.82	25.69	25.16
Conservation tillage	31.77	31.77	19.06	18.67
No-till	5.33	5.33	3.32	3.25
Corn after soybeans:				
No winter cover	69.07	69.07	41.44	40.58
Winter cover	48.35	48.35	29.01	28.41
Conservation tillage	37.30	37.30	22.38	21.91
No-till	5.53	5.53	3.32	3.25
Soybeans after corn:				
No winter cover	66.30	66.30	39.78	38.96
Winter cover	51.11	51.11	30.67	30.03
Conservation tillage	35.92	35.92	21.55	21.10
No-till	5.53	5.53	3.32	3.25

[a]Assumes AOE measure of erosion.

[b]The contour cropping p factor is the same as straight row practices under this land group in this MLRA. Hence, there is no change in erosion levels.

Table 13. Annual and accumulated erosion levels for selected crop sequences in MLRA 107

Crop sequence	Annual erosion[a]	20 years erosion	50 years erosion
	tons/acre		
Corn after corn	19.06	381.2	953.0
Corn after soybeans	22.38	447.6	1,119.0
Soybeans after corn	21.55	431.0	1,077.5

[a]Assume AOE measure of erosion.

impacts for corn and soybeans in MLRA 109 are reported in Table 14. For the above example, corn yields would be reduced 0.028 bushels in the corn after corn sequence, 0.033 bushels in the corn after soybeans sequence, and 0.031 bushels of soybeans in the soybean after corn sequences. Clearly, erosion has a rather slight impact to crop productivity in this example.

We have only accounted for yield impacts, however. The next step is to quantify the nitrogen and phosphorus needs for this rotation. Presently, our yields by crop sequence on a per acre basis are:

Corn after corn	189.2 bushels per acre
Corn after soybeans	171.2 bushels per acre
Soybeans after corn	58.9 bushels per acre

Using the information provided in Table 15 for Land Group 4, the following per acre nitrogen and phosphorus needs are projected to be:

Table 14. Yield impact coefficients as a result of erosion

Land group	Corn	Soybeans
2	2.69×10^{-5}	2.542×10^{-5}
3	1.196×10^{-5}	1.179×10^{-5}
4	1.3×10^{-5}	1.34×10^{-5}
5	NA	NA
6	7.468×10^{-5}	1.164×10^{-5}
7	2.356×10^{-5}	1.952×10^{-5}
8	1.975×10^{-5}	1.488×10^{-5}

	Nitrogen	Phosphorus
Corn after corn	238.4	62.4
Corn after soybeans	282.5	78.8
Soybeans after corn	0.0	42.4

Once these are projected, additional nitrogen needs caused by erosion of the surface layers of soil must be computed. These are presented in Table 16. These coefficients when multiplied by accumulated tonnes per hectare will determine additional nutrient needs of the plant caused by erosion. For corn, this coefficient is 2,241 * 1.32 + 10^{-5} * 1,119.0 for the corn after soybean sequence. This additional nitrogen requirement for corn on this acre of land is 2,819.1 * 10^{-5} + 3,310.1 x 10^{-5} times the two-thirds of an acre that corn is grown on. Since soybeans require 0 nitrogen, this results in an additional nitrogen requirement of 0.06 pounds per acre. Similar calculations are conducted for phospherous.

Table 15. Nitrogen and phosphorus requirements by land group for MLRAs 102A, 102B, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, and 115

	Land Group							
	1	2	3	4	5	6	7	8
	pounds of nitrogen/bushel							
Corn after corn	1.02	1.11	1.15	1.26	NA	1.09	1.03	1.53
Corn after legume hay	1.10	1.27	1.32	1.41	NA	1.24	1.22	1.56
Corn after nonlegume hay	1.00	1.28	1.32	1.45	NA	1.20	1.16	1.61
Corn after soybeans	1.22	1.33	1.40	1.65	NA	1.38	1.26	1.91
Corn after sorghum silage	1.21	1.37	1.46	1.54	NA	1.33	1.33	1.80
Corn after wheat	0.82	1.18	1.21	1.26	NA	1.08	1.06	1.41
Soybeans after corn	0.0	0.0	0.0	0.0	NA	0.0	0.0	0.0
Soybeans after soybeans	0.0	0.0	0.0	0.0	NA	0.0	0.0	0.0
	pounds of phosphorus							
Corn after corn	0.43	0.43	0.39	0.33	NA	0.60	0.37	0.55
Corn after legume hay	1.09	1.12	1.00	1.05	NA	0.96	1.13	1.05
Corn after nonlegume hay	0.39	0.35	0.31	0.45	NA	0.30	0.36	0.42
Corn after soybeans	0.59	0.53	0.52	0.46	NA	0.48	0.53	0.50
Corn after sorghum silage	0.49	0.48	0.47	0.41	NA	0.43	0.46	0.57
Corn after wheat	0.40	0.46	0.46	0.44	NA	0.42	0.39	0.46
Soybeans after corn	0.30	0.28	0.33	0.34	NA	0.39	0.28	0.46
Soybeans after soybeans	0.87	0.82	0.75	0.72	NA	0.83	0.85	0.92

Table 16. Additional nitrogen and phosphorus needs coefficient

Land group	Corn: Nitrogen impact	Corn: Phosphorus impact	Corn: Lime impact	Soybeans: Phosphorus impact
	(10^{-5})	(10^{-5})	(10^{-5})	(10^{-5})
1	0.0	0.0	0.0	0.0
2	3.93	9.22	8.50	37.70
3	1.36	5.56	8.89	9.52
4	1.32	5.56	7.64	10.53
5	NA	NA	NA	NA
6	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	1.57	15.80	4.27	8.30

APPENDIX A

Producing Area	MLRA Assignment	State Assignment	Producing Area	MLRA Assignment	State Assignment
1	143	Maine	25	98	Michigan
2	144B	New Hampshire	26	94A	Michigan
3	144A	Mass.	27	99	Michigan
4	144A	Conn.	28	139	Ohio
5	144B	Vermont	29	101	New York
6	142	Vermont	30	127	Penn
7	143	New York	31	126	Ohio
8	149A	New Jersey	32	111	Ohio
9	148	Penn.	33	128N	West Virginia
10	140	Penn.	34	120	Kentucky
11	136	Virginia	35	111	Indiana
12	147	W. Virginia/Mary.	36	122	Tennesee
13	153A	N. Carolina	37	128	Tennessee
14	133A	S. Carolina	38	123	Tennessee
15	136	Georgia	39	103	Minnesota
16	154	Florida	40	90	Wisconsin
17	156A	Florida	41	108	Iowa
18	133A	Georgia	42	115	Illinois
19	133A	Alabama	43	114	Illinois
20	135	Alabama	44	134	Arkansas
21	133A	Mississippi	45	133B	Louisiana
22	93	Minnesota	46	151	Louisiana
23	95A	Wisconsin	47	56	N. Dakota
24	110	Illinois	48	52	Montana

Producing Area	MLRA Assignment	State Assignment	Producing Area	MLRA Assignment	State Assignment
49	43	Montana	73	85	Texas
50	58A	Montana	74	77	Texas
51	58B	Wyoming	75	81	Texas
52	54	N. Dakota	76	83A	Texas
53	55B	S. Dakota	77	51	Colorado
54	67	Colorado	78	42	New Mexico
55	65	Nebraska	79	42	Texas
56	102B	Nebraska	80	70	New Mexico
57	107	Nebraska	81	83B	Texas
58	73	Kansas	82	34	Wyoming/Colorado
59	75	Nebraska	83	48A	Colorado
60	109	Missouri	84	35	Utah
61	116A	Arkansas	85	35	Arizona
62	69	Colorado	86	30	Arizona
63	78	Kansas	87	40	Arizona
64	112	Oklahoma	88	28A	Utah
65	77	Texas	89	28A	Utah
66	84	Oklahoma	90	28B	Nevada
67	77	Texas	91	23	Nevada
68	78	Oklahoma	92	43	Idaho
69	133B	Texas	93	8	Washington
70	133B	Texas	94	11	Idaho
71	87	Texas	95	43	Idaho
72	77	Texas	96	3	Oregon

Producing Area	MLRA Assignment	State Assignment
97	3	Washington
98	23	Oregon
99	5	California
100	21	California
101	17	California
102	15	Califonia
103	15	California
104	30	California
105	26	California