The Kansas Dam Inventory Project

Final Report

Kansas Biological Survey Report #114
The University of Kansas
Lawrence, Kansas 66045

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Report Prepared by:
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Credits

The Kansas Dam Inventory Project was created at the Kansas Applied Remote Sensing (KARS) Program of the Kansas Biological Survey. This project was carried out under the sponsorship of the Kansas Department of Agriculture's Division of Water Resources (DWR).

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INVENTORY OF DAMS USING REMOTELY SENSED SATELLITE IMAGERY

Quarterly Report
February 18, 2003
Prepared by: Brianna N. Mosiman and Stephen L. Egbert

Objective: Create an inventory of water bodies impounded by dams that are likely within the Chief Engineer's jurisdiction (50 acre feet) and currently do not have permits. During this quarter the following counties were completed: Butler, Douglas, Jackson, Jefferson, Johnson, Leavenworth, Miami, Sedgwick, and Shawnee counties.

Contents:

1) Methods and Results

The water map of each county was created using the Landsat Thematic Mapper multispectral spring, summer, and fall images from 2000 and 2001. An unsupervised classification was applied to the 6 band multispectral image with an output of 100 clusters. Each cluster was identified as either water or non-water based on visual inspection and ancillary data. We then applied post processing that eliminated water bodies under a spatial threshold that was determined on a county by county basis (Table 1).

County	WS #	TOD Area (ac)	Volume/Ac-ft	Threshold
Butler	DBU-0299	7.93	49.01	7
Brown	DBR-0231	4.32	50.74	3.5
Jackson	DJA-0158	6.26	44.05	6
Jefferson	DJF-0363	4.1	50.4	3.5
Johnson	DJO-0146	5.4	57.5	4
Leavenworth	DLV-0220	4.61	42.92	4.5
Marhsall	DMS-0112	5.4	44	5
Miami	DMI-0197	5.92	43.37	5.5
Osage	DOS-0180	6.11	40.78	6
Sedgewick	DSG-0082	8.76	68.38	6.0
Shawnee	DSN-0559	5.32	54.39	4.5

Table 1. The smallest water body still containing 50 acre/feet of water was used as a threshold for determining the size of water body that could be eliminated during post-processing of the water mask on a county by county basis.

The legal descriptions of recorded dam permits provided by the DWR were converted to both UTM coordinates (to match the projection of our imagery) and latitude and longitude as requested by the DWR. The points were imported into ARC and then converted to a shapefile in ArcView. The dam permits were superimposed over the water mask and recorded permits were evaluated. In order to view the database of permitted

dams provided by the DWR, with the addition of geographic information, the individual county shape files can be joined to the table "dams_dwr". The field used to join the two tables is the "Unique ID" field from the DWR table and the "county_pts15" (the second id field) field from the individual county shape files. Some have already been joined.

A point coverage was created by visual inspection of water bodies without dam permits. Both Landsat ETM+ imagery and 1 meter resolution aerial photography from Terra Server (http://terraserver.homeadvisor.msn.com/) was used to visually inspect and evaluate classified water bodies to determine whether further inspection was needed. Water bodies not flagged for further evaluation, but visible on the water mask, include natural lakes (such as oxbow lakes), cooling ponds, and sewage treatment ponds. The total number of water bodies identified for further inspection from the nine counties is 58 (Table 2). Some water bodies do not fit the general characteristics of dams, particularly in Miami county where several water bodies are on a flood plain, with no visible dam or stream creating the water body, but most likely not natural.

Douglas	4
Johnson	3
Jefferson	2
Butler	16
Shawnee	3
Miami	14
Leavenworth	7
Jackson	1
Sedgewick	9

Table 2. Number of unpermitted dams by county.

The database for the unpermitted dams includes the legal description, county location, geographic coordinates, area and estimated volume. The area was calculated by converting the polygon (water body in square meters) to acres. Volume was estimated using linear regression analysis in SPSS software. The regression analysis was not used to eliminate water bodies smaller than 50 acre/feet, the minimum threshold value was used. A regression equation was determined separately for each county; error estimates and coefficients were also recorded (Tables 3-10).

County	Johnson
Adj. R^2	0.657
F	65
B_0	4.583
B_1	7.347
Equation	V=4.583+(7.347*Area)

Table 3. Johnson county regression equation.

County	Jefferson
Adj. R^2	0.674
F	79.721
B_0	4.93
B_1	7.387
Equation	V=4.93+(7.387*Area)

Table 4. Jefferson county regression equation.

County	Sedgewick
Adj. R^2	0.851
F	58.095
B_0	-25.964
B_1	7.123
Equation	V=-25.964+(7.123*Area)

Table 5. Sedgewick county regression equation.

County	Butler
Adj. R^2	0.788
F	131.197
B_0	41.643
B_1	6.636
Equation	V=41.643+(6.636*Area)

Table 6. Butler county regression equation

County	Shawnee
Adj. R^2	0.719
F	98.084
B_0	8.291
B_1	6.112
Equation	V=8.291+(6.112*Area)

Table 7. Shawnee county regression equation

County	Jackson
Adj. R^2	0.804
F	268.049
B_0	-19.94
B_1	10.588
Equation	V=-19.94+(10.588*Area)

Table 8. Jackson county regression equation.

County	Leavenworth
Adj. R^2	0.792
F	95.966
B_0	-0.493
B_1	9.385
Equation	V=-.493+(9.385*Area)

Table 9. Leavenworth county regression equation.

County	Miami
Adj. R^2	0.924
F	98.354
B_0	21.659
B_1	10.122
Equation	V=21.695+(10.122*Area)

Table 10. Miami county regression equation. The area and volume data used in the regression equation did not have a normal distribution, but there were not enough data to eliminate outliers.

2) The following information is provided with each county on the ArcView CD
    a) County water mask,
    b) County Landsat Thematic Mapper scene,
    c) Points where permitted dams exist according to the database provided the DWR,
    d) Points corresponding to water bodies that are most likely dams, but do not have permits,
    e) A database for existing permitted dams containing dam ID's, legal descriptions, area and volume information (if available), geographic coordinates and UTM coordinates,
    f) A database for unpermitted dams containing legal descriptions, geographic coordinates, area and estimated volume,
    g) Regression equation used to determine volume,
    h) The spatial threshold used to eliminate water bodies containing less than 50 acre/feet of water

3. Production Schedule

The nine "High Priority" counties have been completed. The "High Medium" priority counties will be complete by the next report, May 15, in addition to most of the "Medium" priority counties. We anticipate completing the entire state by the end of the project.

INVENTORY OF DAMS USING REMOTELY SENSED SATELLITE IMAGERY

Quarterly Report
April 25, 2003
Prepared by: Brianna N. Mosiman and Stephen L. Egbert

Objective and Overview: Create an inventory of water bodies impounded by dams that are likely within the Chief Engineer's jurisdiction (50 acre feet) and currently do not have permits. During this quarter the following counties were completed: Atchison, Bourbon, Brown, Clay, Cloud, Coffey, Cowley, Crawford, Dickenson, Doniphan, Ellis, Finney, Franklin, Greenwood, Lincoln, Linn, Lyon, McPherson, Nemaha, Neosho, Osage, Ottawa, Pottawatomie, Saline, and Wyandotte counties.

Contents:

1. Methods and Results

The water map of each county was created using the Landsat Thematic Mapper multispectral summer images from 2000 and 2001. An unsupervised classification was applied to the 6 band multispectral image with an output of 100 clusters. Each cluster was identified as either water or non-water based on visual inspection and ancillary data. We then applied post processing that eliminated water bodies under a spatial threshold that was determined on a county by county basis (Table 1). After the initial classification, some counties still had some riparian vegetation mixed in with water. To eliminate the misclassification, we performed a clusterbusting technique to eliminate vegetation from the water mask. Clusterbusting was performed on the following counties: Cloud, McPherson, Dickenson, Greenwood, Lincoln, Nemaha, and Saline.

County	WS #	TOD Area (ac)	Volume/Ac-ft	Threshold (ac)
Atchison	DAT-0161	4.37	33.16	4
Bourbon	NA			3
Brown	DBR-0231	4.32	50.74	3
Clay	DCY-0173	7.09	44.5	6
Cloud	DCD-0142	7.1	53	5.5
Coffey	DCF-0069	6.7	38.4	6
Cowley	NA			3
Crawford	DCR-0057	10.05	41.39	9
Dickenson	DDK-0106	4.8	29.5	4
Doniphan	DDP-0020	4.03	42.8	3
Ellis	DEL-0110	5.63	39.79	4
Finney	NA			3
Franklin	DFR-0095	8.6	51.33	7

Greenwood	DGW-0123	6.42	50.4	5
Lincoln	DLC-0180	6.6	45.2	5
Linn	DLN-0108	4.4	59	3
Lyon	DLY-0072	5.74	48.25	4.5
McPherson	DMP-0035	6.8	42	5
Nemaha	DNM-0236	5.42	44.41	4
Neosho	DNO-0076	6.78	55.18	4.5
Osage	DOS-0180	6.11	40.78	5
Ottawa	DOT-0240	6.98	48.64	5
Pottawa	DPT-0117	5.21	40	4
Saline	DSA-0164	8	47.4	7
Wyandotte	DWY-0102	4.3	50.9	3

Table 1. The smallest water body still containing 50 acre/feet of water was used as a threshold for determining the size of water body that could be eliminated during post-processing of the water mask on a county by county basis.

The legal descriptions of recorded dam permits provided by the DWR were converted to both UTM coordinates (to match the projection of our imagery) and latitude and longitude as requested by the DWR. The points were imported into ARC and then converted to a shapefile in ArcView. The dam permits were superimposed over the water mask and recorded permits were evaluated. In order to view the database of permitted dams provided by the DWR, with the addition of geographic information, the individual county shape files can be joined to the table "dams_dwr". The field used to join the two tables is the "Unique ID" field from the DWR table and the "county_pts15" (the second id field) field from the individual county shape files. Some tables have already been joined.

A point coverage was created by visual inspection of water bodies without dam permits. Both Landsat ETM+ imagery and 1 meter resolution aerial photography from Terra Server (http://terraserver.homeadvisor.msn.com/) was used to visually inspect and evaluate classified water bodies to determine whether further inspection was needed. Water bodies not flagged for further evaluation, but visible on the water mask, include natural lakes (such as oxbow lakes), cooling ponds, and sewage treatment ponds. The total number of water bodies identified for further inspection from the 25 counties completed this quarter is 201 (Table 2).

Atchison	3
Bourbon	17
Brown	12
Clay	1
Cloud	0
Coffey	3
Cowley	7
Crawford	4

Dickenson	11
Doniphan	2
Ellis	16
Finney	2
Franklin	8
Greenwood	18
Lincoln	12
Linn	14
Lyon	12
McPherson	14
Nemaha	10
Neosho	12
Osage	6
Ottawa	10
Pottawatomie	0
Saline	7
Wyandotte	0

Table 2. Number of unpermitted dams by county.

The database for the unpermitted dams includes the legal description, county location, geographic coordinates, area and estimated volume. The area was calculated by converting the polygon (water body in square meters) to acres. Volume was estimated using linear regression analysis in SPSS software. The regression analysis was not used to eliminate water bodies smaller than 50 acre/feet, the minimum threshold value was used. A regression equation was determined separately for each county; error estimates and coefficients were also recorded (Tables 3-22). A regression analysis was not performed for the following counties-Cloud, Pottawatomie, and Wyandotte- because no unpermitted dams were recorded.

County	Atchison
Adj. R^2	0.833
F	226.188
B_0	11.869
B_1	9.852
Equation	V=11.869+(9.852*Area)

Table 3. Atchison county regression equation.

County	Bourbon
Adj. R^2	0.585
F	32.051
B_0	58.305
B_1	5.746
Equation	V=58.305+(5.746*Area)

Table 4. Bourbon county regression equation.

County	Brown
Adj. R^2	.908
F	604.540
B_0	-6.526
B_1	9.977
Equation	V=-6.526+(9.977*Area)

Table 5. Brown county regression equation.

County	Clay
Adj. R^2	0.368
F	4.496
B_0	21.990
B_1	3.969
Equation	V=21.990+(3.969*Area)

Table 6. Clay county regression equation.

County	Coffey
Adj. R^2	.812
F	74.581
B_0	-5.126
B_1	8.035
Equation	V=-5.126+(8.035*Area)

Table 7. Coffey county regression equation.

County	Cowley
Adj. R^2	0.911
F	316.843
B_0	12.872
B_1	8.201
Equation	V=12.872+(8.201*Area)

Table 8. Cowley county regression equation.

County	Crawford
Adj. R^2	0.490
F	25.05
B_0	23.184
B_1	3.784
Equation	V=23.184+(3.784*Area)

Table 9. Crawford county regression equation.

County	Dickenson
Adj. R^2	0.979
F	756.231
B_0	33.628
B_1	8.972
Equation	V=33.628+(8.972*Area)

Table 10. Dickenson county regression equation.

County	Doniphan
Adj. R^2	0.659
F	39.69
B_0	14.732
B_1	6.046
Equation	V=14.732+(6.046*Area)

Table 11. Doniphan county regression equation.

County	Ellis
Adj. R^2	1.0
F	34797.640
B_0	2.813
B_1	7.227
Equation	V=2.813+(7.227*Area)

Table 12. Ellis county regression equation. Only four points were available to build the equation.

County	Finney
Adj. R^2	0.701
F	5.678
B_0	258.939
B_1	9.567
Equation	V=258.939+(9.567*Area)

Table 13. Finney county regression equation. Only three points were used to build the regression equation. The estimates do not appear to be credible.

County	Franklin
Adj. R^2	0.939
F	352.407
B_0	-17.8
B_1	9.129
Equation	V=-17.8+(9.129*Area)

Table 14. Franklin county regression equation.

County	Greenwood
Adj. R^2	0.955
F	1083.852
B_0	-37.024
B_1	10.931
Equation	V=-37.024+(10.931*Area)

Table 15. Greenwood county regression equation.

County	Lincoln
Adj. R^2	0.961
F	793.039
B_0	.117
B_1	11.264
Equation	V=.117+(11.264*Area)

Table 16. Lincoln county regression equation.

County	Linn
Adj. R^2	0.573
F	53.261
B_0	19.355
B_1	7.124
Equation	V=19.355+(7.124*Area)

Table 17. Linn county regression equation.

County	Lyon
Adj. R^2	0.911
F	530.247
B_0	-23.612
B_1	8.871
Equation	V=-23.612+(8.871*Area)

Table 18. Lyon county regression equation.

County	McPherson
Adj. R^2	0.701
F	15.048
B_0	41.189
B_1	1.118
Equation	V=41.189+(1.118*Area)

Table 19. McPherson county regression equation.

County	Nemaha
Adj. R^2	0.968
F	2003.061
B_0	-7.518
B_1	8.846
Equation	V=-7.518+(8.846*Area)

Table 20. Nemaha county regression equation.

	Osage
Adj. R^2	0.817
F	94.871
B_0	-38.175
B_1	9.893
Equation	V=-38.175+(9.893*Area)

Table 9. Osage county regression equation.

County	Ottawa
Adj. R^2	0.947
F	252.640
B_0	-39.226
B_1	9.861
Equation	V=-39.226+(9.861*Area)

Table 21. Ottawa county regression equation.

County	Saline
Adj. R^2	0.754
F	34.797
B_0	16.227
B_1	4.457
Equation	V=16.227+(4.457*Area)

Table 22. Saline county regression equation.

2. **ArcView Database Contents**

The following information is provided with each county on the ArcView CD:

i) County water mask,
j) County Landsat Thematic Mapper scene,
k) Points where permitted dams exist according to the database provided by the DWR,
l) Points corresponding to water bodies that are most likely dams, but do not have permits,
m) A database for existing permitted dams containing dam ID's, legal descriptions, area and volume information (if available), geographic coordinates and UTM coordinates,
n) A database for unpermitted dams containing legal descriptions, geographic coordinates, area and estimated volume,
o) Regression equation used to determine volume,
p) The spatial threshold used to eliminate water bodies containing less than 50 acre/feet of water

3. **Production Schedule**

The 25 "Medium High Priority" counties have been completed. The "Medium" priority counties will be complete by the next report, May 15.

INVENTORY OF DAMS USING REMOTELY SENSED SATELLITE IMAGERY

Final Report
June 15, 2003
Prepared by: Brianna N. Mosiman

Objective and Overview: Create an inventory of water bodies impounded by dams that are likely within the Chief Engineer's jurisdiction (50 acre feet) and currently do not have permits. During this quarter the following counties were completed: Marshall, Labette, Ford, Chase, Harvey, Reno, Chautauqua, Osborne, Wabaunsee, Russell, Wilson, Ellsworth, Anderson, Graham, Montgomery, Morris, Geary, Marion, Smith, Seward, Riley, Phillips, Rooks, Republic, Elk, Kingman, Hamilton, Cherokee, Mitchell, Barber, Washington, Sumner, Jewell, Allen, Grant, Gray, Ness, Meade, Rice, Kearny, Barton, Thomas, Trego, Pratt, Stevens, Haskell, Sheridan, Logan, Gove, Rush, Woodson, Pawnee, Lane, Cheyenne, Harper, Sherman, Hodgeman, Rawlins, Decatur, Stanton, Scott, Clark, Morton, Norton, Kiowa, Wallace, Comanche, Wichita, Edwards, Stafford, Greeley.

Contents:

1. Methods and Results

The water map of each county was created using the Landsat Thematic Mapper multispectral summer images from 2000 and 2001. An unsupervised classification was applied to the 6 band multispectral image with an output of 100 clusters. Each cluster was identified as either water or non-water based on visual inspection and ancillary data. We then applied post processing that eliminated water bodies below a spatial threshold that was determined on a county by county basis (Table 1). As we moved further west for this project, we had less data available to determine a threshold unique to each county for the elimination process for one of two reasons: in some counties there were not enough permitted dams to generate a reasonable estimate of the threshold value; or, in some counties either data for volume or area were missing and we were unable to identify a relationship between volume and area. To resolve this issue, we consolidated data from counties that fit into the same physiographic region, e.g. High Plains, Smokey Hills, Red Hills, to keep as consistent as possible similar terrain and drainage patterns that help determine volume (Figure 1).

After the initial classification, some counties had some irrigated cropland misclassified as water, but without a distinct water class. This is primarily because in many counties in western Kansas there are not enough water bodies to be distinguished statistically from irrigated cropland. In order to break out water, we applied a seeding

method that used water pixels to find statistically similar pixels. This seeding approach was applied to the following counties: Grant, Gray, Kingman, Clark, Comanche, Cheyenne, Decatur, Edwards, Greeley, Gove, Hodgeman, Harper, Haskell, Kearney, Kiowa, Logan, Lane, Meade, Morton, Ness, Pawnee, Pratt, Rawlins, Rice, Rush, Scott, Sheridan, Stevens, Stanton, Thomas, Wallace, and Wichita.

County	WS #	TOD Area (ac)	Volume/Ac-ft	Threshold (ac)
Marshall	DMS-0112	5.4	44	4.5
Labette	DLB-0084	12.14	46.28	11.5
Ford	NA			4
Chase	DCS-0110	7.4	40.19	7.5
Harvey	NA			5
Reno	NA			5
Chautauqua	DCQ-0116	7.67	48.12	7
Osborne	NA			5
Wabaunsee	DWB-0047	4.24	51.41	3.5
Russell	NA			5
Wilson	NA			5
Ellsworth	DEW-0069	7.6	46	7.5
Anderson	NA			4
Graham	NA			4
Montgomery	DMG-0050	5	40.5	5
Morris	DMR-0075	6.88	44.57	6.5
Geary	DGE-0070	7.8	54	6
Marion	DMN-0049	9.44	55.07	7
Smith	DSM-0161	5.34	44.54	5
Seward	NA			10
Riley	DRL-0062	8.3	47.5	7.5
Phillips	NA			4
Rooks	NA			4
Republic	DRP-0111	6.46	45.39	6
Elk	DEK-0089	7.45	43.34	7
Kingman	NA			4
Hamilton	NA			4
Cherokee	NA			4
Mitchell	DMC-0035	7.94	57.71	5.5
Barber	DBA-0078	5.2	56.39	4
Washington	DWS-0105	6.5	45	6
Sumner	NA			4

Jewell	DJW-0125	9.8	38	9.5
Allen	NA			4
Grant	NA			4
Gray	NA			4
Ness	DNS-0080-X	14.2	49.88	12
Meade	NA			4
Rice	DRC-0028	8	52.5	6
Kearny	NA			6
Barton	DBT-0023	6.14	43.3	6
Thomas	NA			4
Trego	NA			4
Pratt	NA			4
Stevens	NA			4
Haskell	DHS-0005	13.3	45.2	12.5
Sheridan	NA			4
Logan	NA			4
Gove	NA			4
Rush	NA			4
Woodson	DWO-0045	10	40.85	10
Pawnee	NA			4
Lane	DLN-0090	8.27	48.87	4
Cheyenne	NA			4
Harper	NA			4
Sherman	NA			4
Hodgeman	NA			4
Rawlins	NA			4
Decatur	NA			4
Stanton	NA			4
Scott	NA			4
Clark	NA			4
Morton	NA			4
Kiowa	NA			4
Wallace	NA			4
Comanche	DCM-0039	8.77	45.91	8
Wichita	DWH-0030	10.09	44.91	8
Edwards	NA			4
Stafford	NA			5
Greeley	NA			4

Table 1. The smallest water body still containing 50 acre/feet of water was used as a threshold for determining the size of water body that could be eliminated during post-processing of the water mask on a county by county or by physiographic region basis.

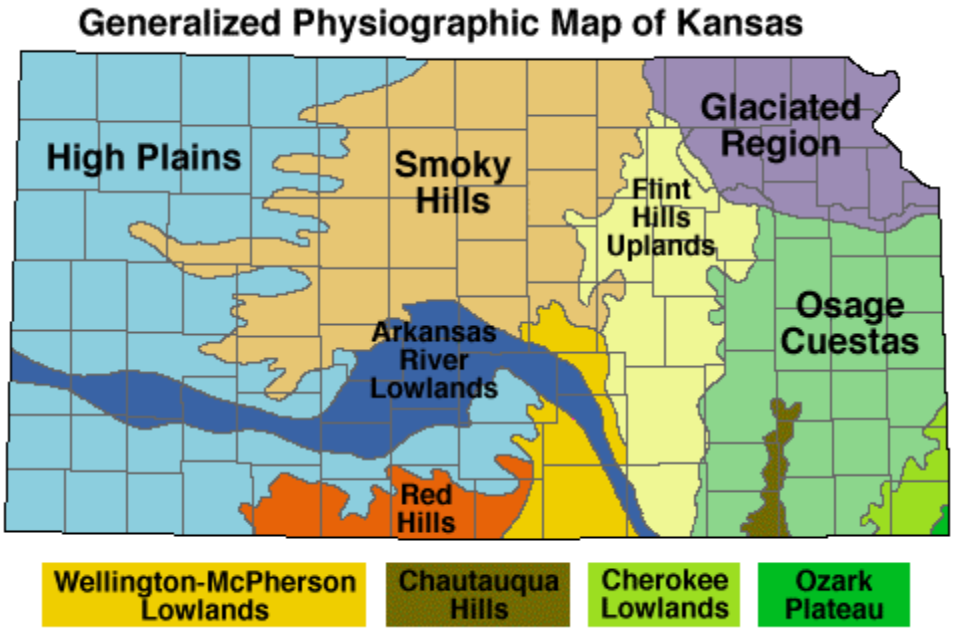

Figure 1. As we moved further west for this project, we had less data available per county to determine a threshold unique to each county for the elimination process and to identify a relationship between volume and area for the regression analysis. To solve this problem we consolidated data from counties that fit into the same physiographic region to keep as consistent as possible similar terrain and drainage patterns that partially determine volume.

The legal descriptions of recorded dam permits provided by the DWR were converted to both UTM coordinates (to match the projection of our imagery) and latitude and longitude as requested by the DWR. The points were imported into ARC and then converted to a shapefile in ArcView. The dam permits were superimposed over the water mask and recorded permits were evaluated. In order to view the database of permitted dams provided by the DWR, with the addition of geographic information, the individual county shape files can be joined to the table "dams_dwr". The field used to join the two tables is the "Unique ID" field from the DWR table and the "county_pts15" (the second id field) field from the individual county shape files. Some tables have already been joined.

A point coverage was created by visual inspection of water bodies without dam permits. Both Landsat ETM+ imagery and 1 meter resolution aerial photography from Terra Server (http://terraserver.homeadvisor.msn.com/) were used to visually inspect and evaluate classified water bodies to determine whether further inspection was needed. Water bodies not flagged for further evaluation, but visible on the water mask, include

natural lakes (such as oxbow lakes), cooling ponds, and sewage treatment ponds. Some counties were particularly problematic because of their landscape. Barber County, in the Red Hills region of south-central Kansas, incorporated the largest number of unpermitted dams (58) as determined by our methods. The Red Hills region is full of caves, buttes, mesas, and sinkholes and are unique to this part of Kansas. Some of these water bodies we have labeled as dams could be natural water bodies but appear similar to dams in the satellite imagery. Toronto Lake in Woodson County did not have a permit from the DWR present, but we did **not** flag it as an unpermitted dam. There is also a dam in Geary County that does not have a legal coordinate with it, although the geographic coordinates are available. This is most likely because it is on Fort Riley, which does not fall under the township/range coordinates in the LEO program. The total number of water bodies identified for further inspection from the 70 counties completed this quarter is 413 (Table 2).

County	# of Dams
Marshall	14
Labette	4
Ford	3
Chase	8
Harvey	5
Reno	15
Chautauqua	3
Osborne	27
Wabaunsee	8
Russell	5
Wilson	28
Ellsworth	1
Anderson	35
Graham	2
Montgomery	16
Morris	6
Geary	1
Marion	2
Smith	3
Seward	1
Riley	0
Phillips	6
Rooks	7
Republic	1
Elk	13
Kingman	26

Hamilton	0
Cherokee	11
Mitchell	0
Barber	58
Washington	2
Sumner	10
Jewell	0
Allen	8
Grant	0
Gray	0
Ness	2
Meade	5
Rice	3
Kearny	0
Barton	1
Thomas	0
Trego	7
Pratt	6
Stevens	0
Haskell	0
Sheridan	1
Logan	1
Gove	3
Rush	4
Woodson	2
Pawnee	3
Lane	4
Cheyenne	0
Harper	9
Sherman	0
Hodgeman	1
Rawlins	1
Decatur	1
Stanton	1
Scott	0
Clark	14
Morton	0
Kiowa	11
Wallace	0

Comanche	0
Wichita	0
Edwards	1
Stafford	3
Greely	0

Table 2. Number of unpermitted dams by county.

The database for the unpermitted dams includes the legal description, county location, geographic coordinates, area and estimated volume. The area was calculated by converting each polygon (water body in square meters) to acres. Volume was estimated using linear regression analysis in SPSS software. The regression analysis was not used to eliminate water bodies smaller than 50 acre/feet; the minimum threshold value was used. A regression equation was determined by physiographic regions; error estimates and coefficients were also recorded. A regression analysis was not performed for the following counties— Riley, Hamilton, Mitchell, Grant, Gray, Kearny, Thomas, Jewell, Stevens, Haskell, Cheyenne, Sherman, Morton, Wallace, Comanche, Wichita, Greely, Riley- because no unpermitted dams were recorded. The High Plains regression analysis was based on the following counties— Cheyenne, Decatur, Thomas, Graham, Logan, Gove, Wichita, Lane, Stanton, Grant, Haskell, Stevens, Seward, and Meade counties. Other counties in the High Plains regions were not included because there was no data available. The Smokey Hills regression analysis was based on the following counties— Smith, Jewell, Republic, Washington, Rooks, Osborne, Mitchell, and Ellsworth counties.

County	High Plains
Adj. R^2	.959
F	674.57
B_0	-71.272
B_1	11.496
Equation	V=-71.272+(11.496*Area)

Table 3. High Plains regression equation.

County	Smokey Hills
Adj. R^2	.928
F	429.023
B_0	-15.097
B_1	8.187
Equation	V=-15.097+(8.187*Area)

Table 4. Smokey Hills regression equation.

2. **ArcView Database Contents**

The following information is provided with each county on the ArcView CD:

q) County water mask,
r) County Landsat Thematic Mapper scene,

s) Points where permitted dams exist according to the database provided by the DWR,
t) Points corresponding to water bodies that are most likely dams, but do not have permits,
u) A database for existing permitted dams containing dam ID's, legal descriptions, area and volume information (if available), geographic coordinates and UTM coordinates,
v) A database for unpermitted dams containing legal descriptions, geographic coordinates, area and estimated volume,
w) Regression equation used to determine volume,
x) The spatial threshold used to eliminate water bodies containing less than 50 acre/feet of water

3. **Production Schedule**

The entire state has been completed.