Assessment of Watershed Dams

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Stillwater, OK

OACD Annual Meeting
Midwest City, OK
February 28, 2011

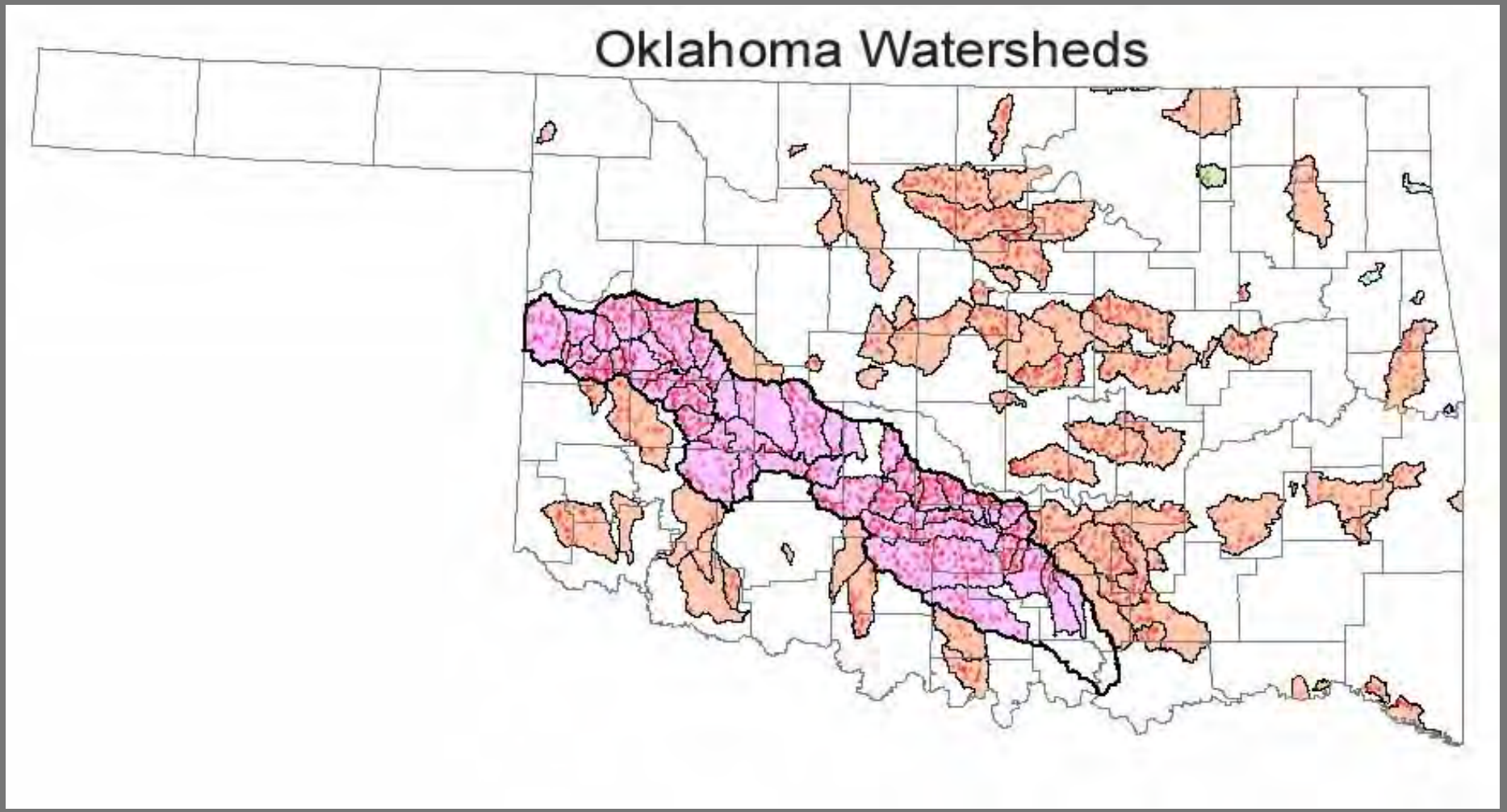
OKLAHOMA CONSERVATION COMMISSION

NRCS
Natural Resources Conservation Service

- Brief Background:
  Importance of assessments to Oklahoma
- What is included in an Assessment Report
- “Next Steps”

USDA Small Watershed Program has been important to Oklahoma for over 60 years

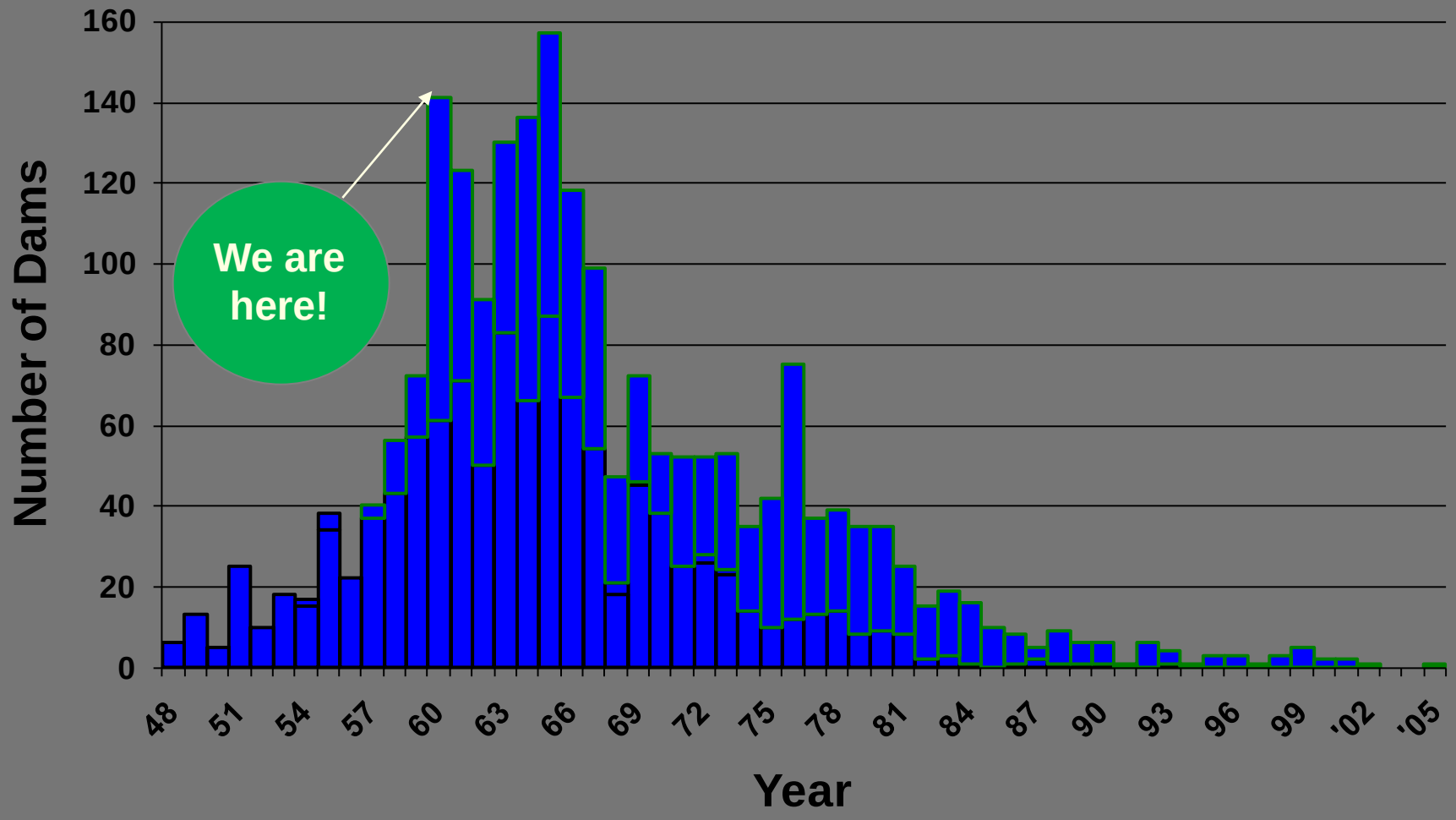
$81 million in benefits each year



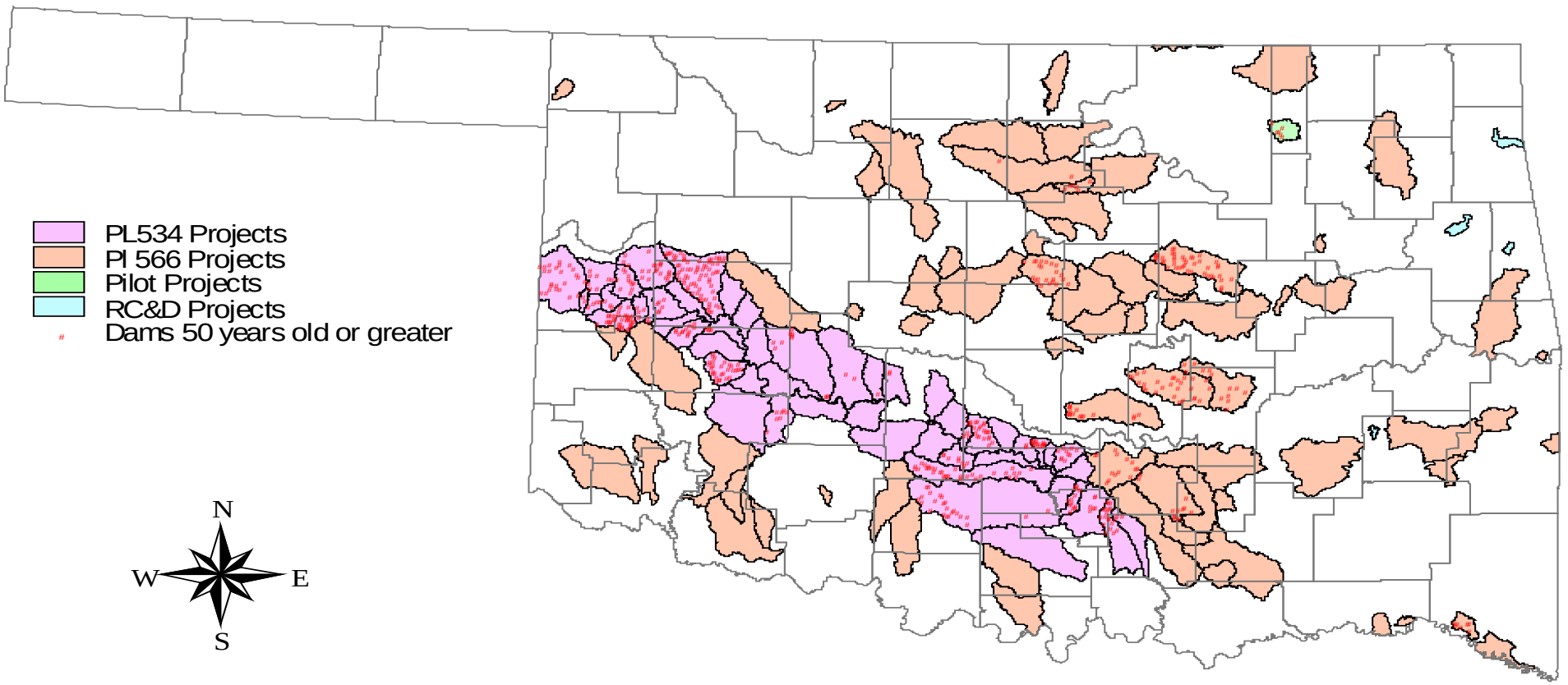
2,107 Dams in 129 Watersheds

(20% of the national total)

Aging Infrastructure
Dams Built Each Year - Oklahoma



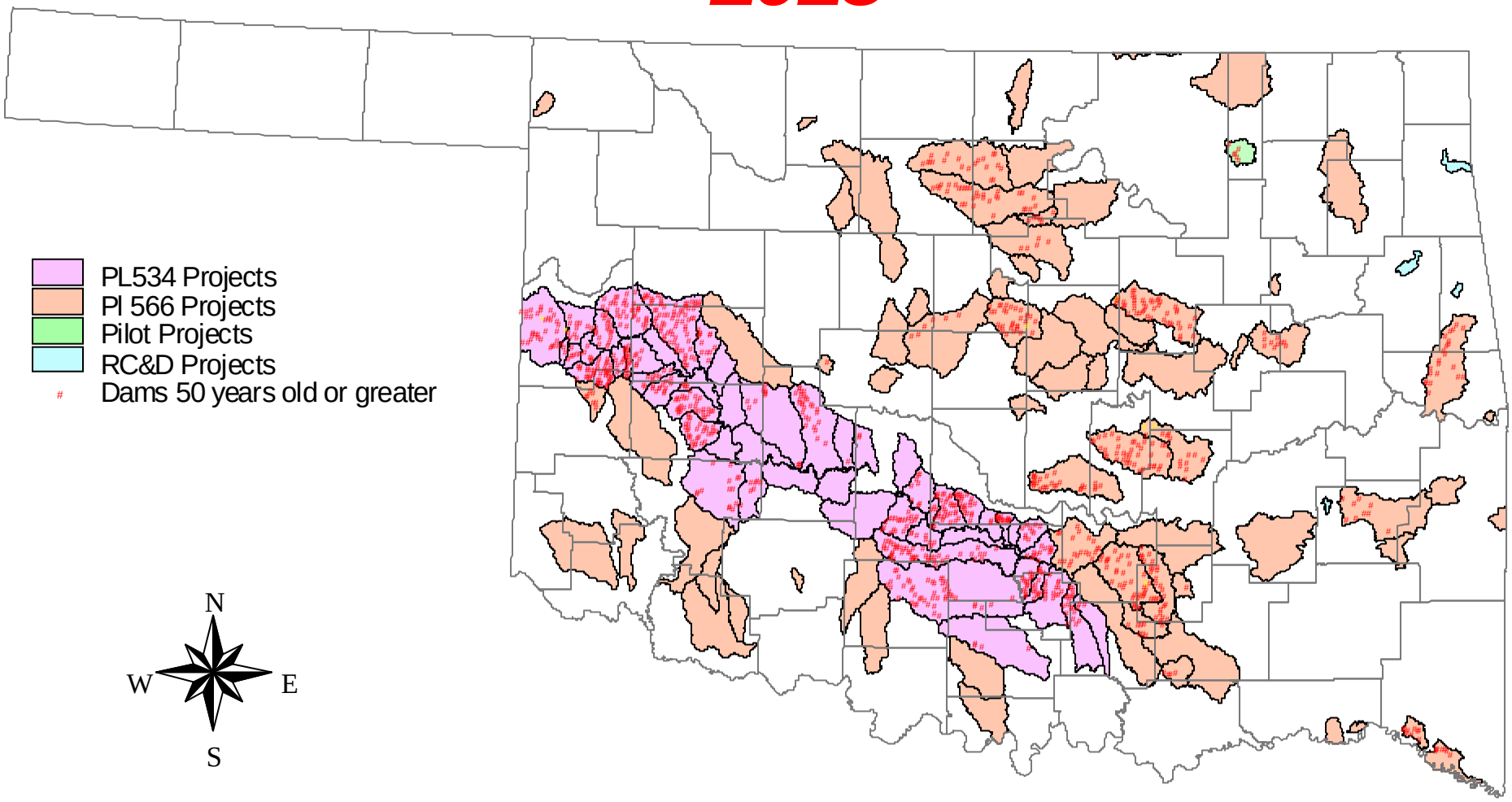
2011



586 Dams at or Beyond Design Life

An average of more than 100 dams per year
will come to the end of their design life
for each of the next 10 years

2015



1090 Dams at or Beyond Design Life

For those of you with at least
20 years of your career remaining…

By the time you retire, virtually all of the watershed dams in Oklahoma will have exceeded their design life.

…and some of the dams will be more than 80 years old

Aging Dams Need Attention!

Sedimentation

Deterioration

Aging Dams Need Attention!

Cracked Pipe

Water Leaking into Pipe

Watershed Dam Can Fail!

Impacts can be devastating to people, the local economy,

and the environment

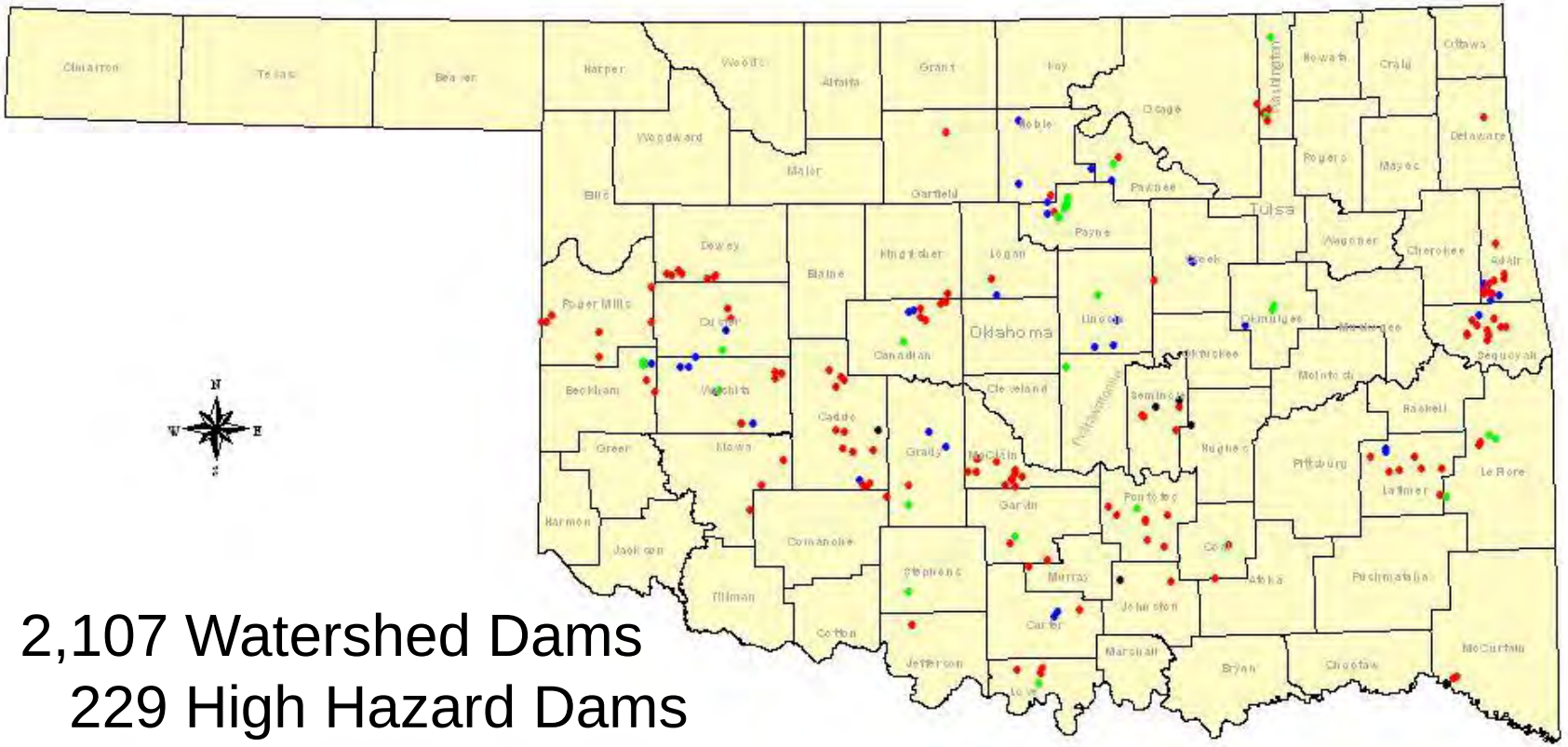
This is one of those times you wished would never occur until this happened!

Public Safety Threats

Downstream development has put people in harms way

Downstream Development !

High Hazard Watershed Dams



2,107 Watershed Dams
229 High Hazard Dams

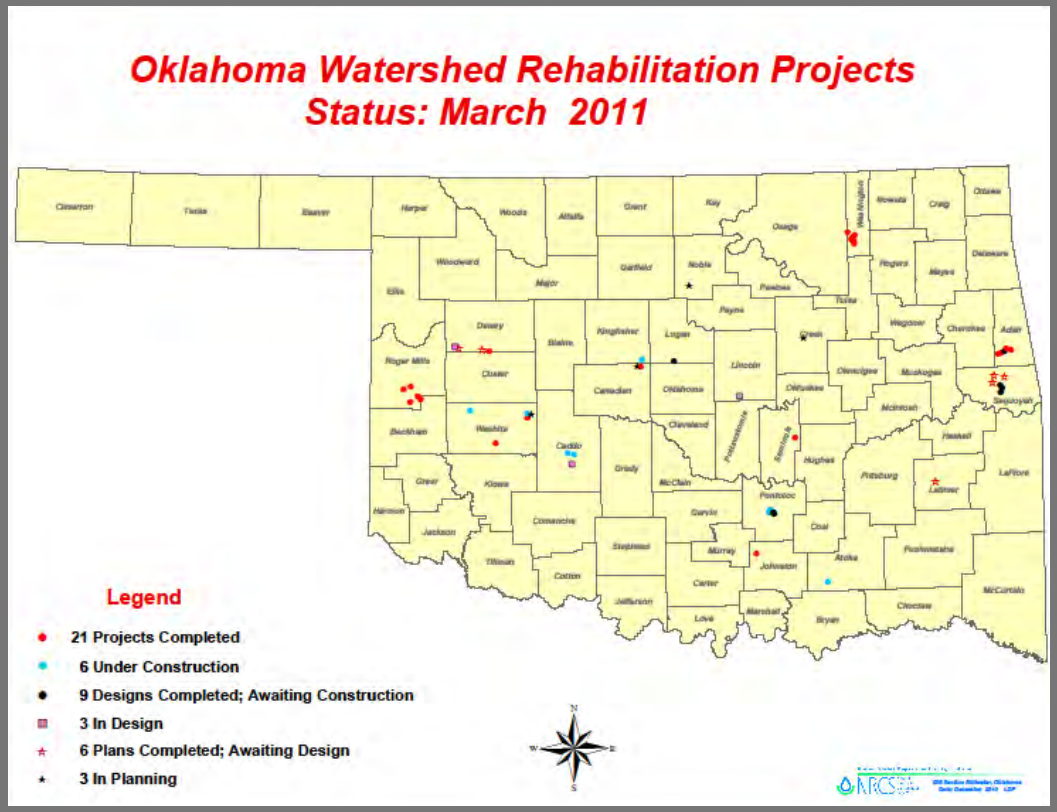
Dams Currently Classified as High Hazard
- Constructed as High Hazard
- Constructed as Significant Hazard
- Constructed as Low Hazard

Located in 42 counties
and 44 Conservation Districts
in 65 Watersheds

NRCS Natural Resources Conservation Service
GIS Section Stillwater, Oklahoma
Date: 11-2006 LDF

Oklahoma's Watershed Rehabilitation Program

- 48 projects funded (1999-2011)
- 21 dams rehabilitated
- 24 dams in implementation (design & construction)
- 3 dams in planning



Watershed Dam Assessment Project

- Assessment of 147 high hazard dams in Oklahoma
- Part of a nationwide effort funded by NRCS that will result in 658 high hazard dams being assessed
- October 1, 2009 – September 30, 2011
- NRCS – OCC agreement

Oklahoma Assessment Team (The A-Team)

- Larry Caldwell, Project Coordinator
- Ray Riley, Hydrologist
- Jim Henley, GIS Specialist
- Dwain Phillips, Technical Writer
- Lil Holkum, Secretary & Data Management
- George Moore, Watershed Technician
- Dennis Boney, Watershed Technician
- Johnny Pelley, Watershed Technician
- Robert Toole, OCC Support
- Mike Sharp, OCC Support
- Gary Utley, NRCS Support

Dam Assessment Tasks

- Gather data
- Complete field site visit to evaluate condition of the dam
- Complete breach analysis & prepare breach inundation map
- Check conformance to current dam safety criteria
- Develop rehabilitation alternatives to meet current dam safety criteria
- Determine cost estimates for each alternative to determine scope of a rehabilitation project

Rehabilitation Assessment Report

Sallisaw Creek Watershed
Dam No. 19

Adair County, Oklahoma
Adair County Conservation District
NID No. OK00082

Population at Risk: 47
Dam Failure Index: 182
Risk Index: 342
Current Hazard Classification: High

Oklahoma Conservation Commission
USDA Natural Resources Conservation Service
October 2010

OKLAHOMA CONSERVATION COMMISSION

NRCS

Written report will be prepared for each assessment

Sallisaw Creek Watershed Dam No. 19 Overview

The dam is located in a rural agricultural area in central Adair County, Oklahoma, in Section 20 T15N R25E. The dam was built on the headwaters of Sallisaw Creek and is located approximately 5.5 miles south and 2.5 miles west of Stilwell, Oklahoma.

The dam was constructed in 1968 by the Adair County Conservation District and the Sallisaw Creek Conservancy District (no longer active) with assistance of the USDA Natural Resources Conservation Service (NRCS) Watershed Program (PL 83-566 Watershed Protection and Flood Prevention Act).

Operation and Maintenance (O&M) of this dam is the responsibility of the Adair County Conservation District. Inspections are conducted annually and after significant storm events. The O&M agreement between the sponsors and Soil Conservation Service (now Natural Resources Conservation Service) was signed on June 27, 1962. The O&M agreement is in effect for 50 years after construction of the dam (2018).

Original Design Information

State	Oklahoma
County	Adair
National Inventory of Dams (NID) No.	OK00082
Latitude	35.76778
Longitude	-94.66672
Service Life of Dam	50 years
Drainage Area	12.75 square miles (8,160 acres)
Height of Dam *	61 feet
Auxiliary Spillway Width	200 feet
Earthen Dam Embankment Volume	374,578 cubic yards
Foundation Seepage Control	Foundation drain with one outlet
Sediment Pool Surface Area	46 acres
Detention Pool Surface Area at Auxiliary Spillway Elevation	272 acres
Original Construction Cost	$191,702
Date Construction Completed	June 20,1968

* Height of dam is the vertical distance between the lowest point across the top of dam and the lowest point at downstream toe of the embankment (usually at the natural stream bed)

Storage Capacities

Submerged Sediment Storage	313 acre-feet
Aerated Sediment Storage	61 acre-feet
Total Sediment Storage	374 acre-feet
Detention Storage	4,422 acre-feet
Other Beneficial Storage	0 acre-feet
Total Storage Capacity at Auxiliary Spillway Elevation	4,796 acre-feet
Surcharge Storage	1,571 acre-feet
Maximum Storage Capacity at Top of Dam Elevation	6,367 acre-feet

Data Gathering

Overview

General description of dam

Field Review to Evaluate the Condition of the Dam

Document the findings

U.S. Department of Agriculture
Natural Resources Conservation Service

OK-PDM-3
Rev. 4-06

WATERSHED STRUCTURE INSPECTION REPORT Eugene

Date of Inspection 1-12-10 Inspection Team Members Boney, Pelley, Moore,

County Adair Watershed Saliisaw Creek Site 23 19

Field Office Stilwell Sponsor Adair County CD

Legal Description Sec 16 T 15 R 23E

"YES" responses need explanation added to "Remarks" section. (ie: What? Where? How much?)
"NO" responses indicate problems not observed during inspection.
Non-applicable items should be lined out.

ITEM	YES	NO	REMARKS
1. General Conditions			
a. Access to dam?			
b. Development in downstream floodplain?			Railroad
c. Development around reservoir?			
2. Embankment			
a. Is vegetative cover inadequate?			
b. Are trees growing on either slope?			
c. Is brush/weed control needed?			
d. Are trees growing at waterline?			
e. Is drift/debris present?			
f. Are cracks, settlement, or bulges present?			
g. Are animal burrows present?			
h. Are cattle trails or beaver trails present?			
3. Front Slope Protection			
a. Any wave damage observed?			
b. Is riprap inadequate?			
c. Are rodent holes present?			
4. Inlet Structure and Gate Valves			
a. Does concrete exhibit deterioration?			
b. Is concrete reinforcement exposed?			
c. Was leakage observed inside inlet?			
d. Any corrosion of metal appurtenances?			
e. Is debris guard obstructed?			Lot of debris
f. Is debris guard corroded?			
g. Is gate stem broken or bent?			
h. Are components missing?			
i. Was gate determined not operational?			Date gate last operated: Don't know
j. Has inlet been modified to alter water surface?			
5. Principal Spillway Conduit			
a. Is concrete conduit deteriorated?			
b. Is metal conduit corroded?			
c. Was leakage observed at pipe joints?			
Auxiliary Spillway			
a. Is vegetative cover inadequate?			
b. Any cattle trails observed?			
c. Any vehicular trails observed?			
d. Is flow area obstructed?			Trees
e. Is control section disturbed?			

General Condition

Development downstream

Development around reservoir

Embankment

Vegetation

Embankment

Cracks, settlement, sinkholes, burrows & livestock trails

Front Slope

Wave action damage

Inlet Structure & Gate Valves

- Debris guard
- Gate & stem condition
- Gate operated
- Modifications
- Deterioration

Principal Spillway Conduit

Deterioration, corrosion or leakage

Video inspection of the principal spillway conduit

Auxiliary Spillway

Vegetative cover, discontinuities, obstructions

Principal Spillway Release Channel

- Scour hole stability
- Conduit submerged
- Conduit support
- Outlet channel
  - Obstructed
  - Degrading

Seepage and Foundation Drains

Fencing

Fence repair needs

Gates open

Over grazing

Occasionally, it might just take another trip to complete the inspection!

Existing Dam Conditions - On-Site Inspection

The purpose of the on-site inspection was to evaluate the existing condition of the dam and indentify any Operation and Maintenance (O&M) needs. The inspection further serves as the basis for computing a risk index, identifying site constraints related to rehabilitation and determining potential rehabilitation alternatives.

The dam was inspected on January 12, 2010, by Oklahoma Conservation Commission assessment team members George Moore, Johnny Pelley, Dennis Boney, and Adair County Conservation District employee, Eugene Kester. An inspection report (OK-PDM-3) was completed (see Appendix 3) and a dam inspection documentation sheet was also completed to supplement the OK-PDM-3 (see Appendix 4). Photographs were taken of the structure during the inspection visit to document current condition of the structure and any problem areas or concerns (photos included in Appendix 5).

The following items were noted during the on-site inspection:

Embankment Condition: There is a good Bermuda grass cover on the dam. There are trees and brush growing on slopes and at the waterline. There are large trees on the right end of the embankment. The top of the dam has some vehicle tracks that should be monitored.

Auxiliary Spillway: There is a good vegetative cover of Bermuda grass, but flow could be restricted by trees immediately downstream from the exit channel. Several cattle and vehicle trails were found in the spillway that should be monitored for erosion problems.

Principal Spillway Inlet: Principal spillway inlet consists of a 30" X 100" concrete open topped inlet 16 feet deep, with a 15" slide gate. The top of the inlet is covered with debris. The Adair County Conservation District equipment manager, Eugene Kester, reported that the slide gate is not operational.

Principal Spillway Conduit: The exposed portion of the 30-inch reinforced concrete conduit appears to be in good condition with no spalling or cracking noted. The inside of the pipe was not videoed because of trees and too much water.

Principal Spillway Outlet and Release Channel: An earthen plunge basin is provided for energy dissipation at the conduit outlet. There is minor erosion in the plunge basin. The invert of the principal spillway conduit outlet is approximately one foot above the elevation of the water in the release channel.

Fence: The fence needs repair and is inadequate for controlling grazing.

Urgent Actions That Should be Addressed Immediately: None

Non-Urgent Actions That Should be Addressed Through Normal Maintenance Activities: The slide gate needs to be replaced, the perimeter fence should be repaired, debris removed from inlet tower, trees and brush removed or chemically controlled. The vehicle and cattle trails in the auxiliary spillway and the trail on the top of the dam should be monitored for erosion problems. The estimated cost of completing this maintenance work is approximately $6,000.

Status of Operation and Maintenance: There were no major concerns identified during the inspection. All identified concerns were either minor in nature or considered to be routine O&M. Operation and maintenance is considered to be up-to-date for this dam; however, the identified O&M issues need to be addressed during normal O&M activities.

Summary of field visit findings

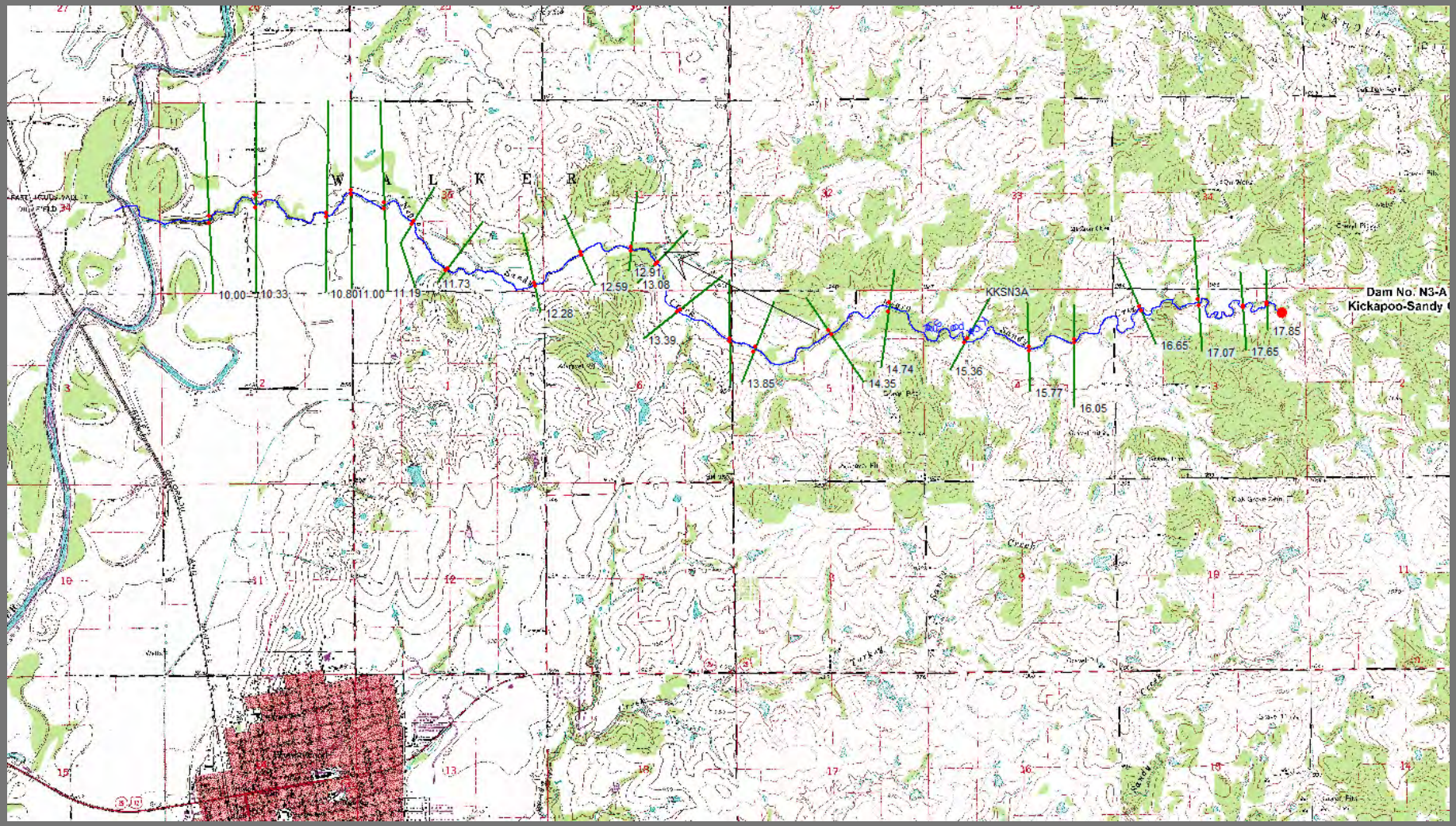
- Urgent
- Non-urgent
- O&M status

Breach Analysis

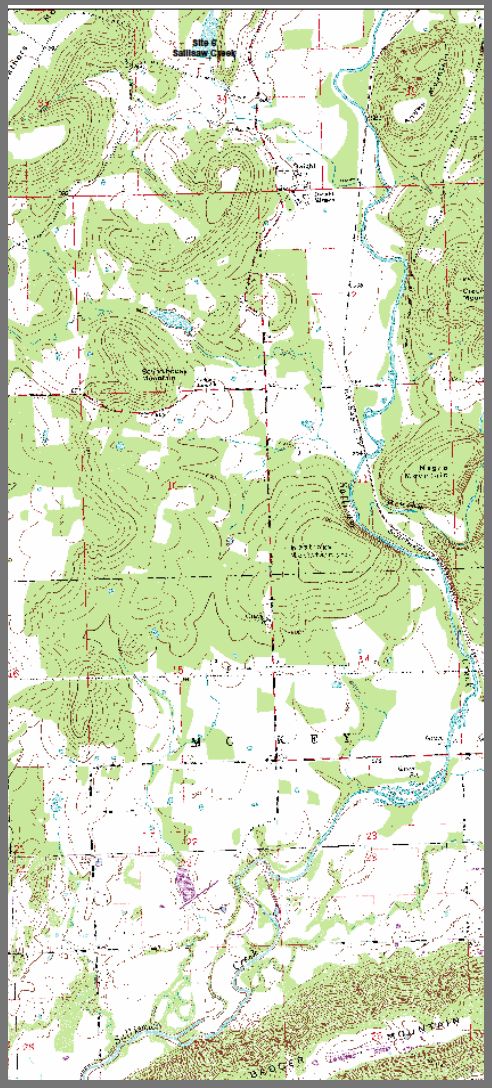
- Verify hazard classification
- Determine area inundated if the dam should fail
- Identify at-risk properties

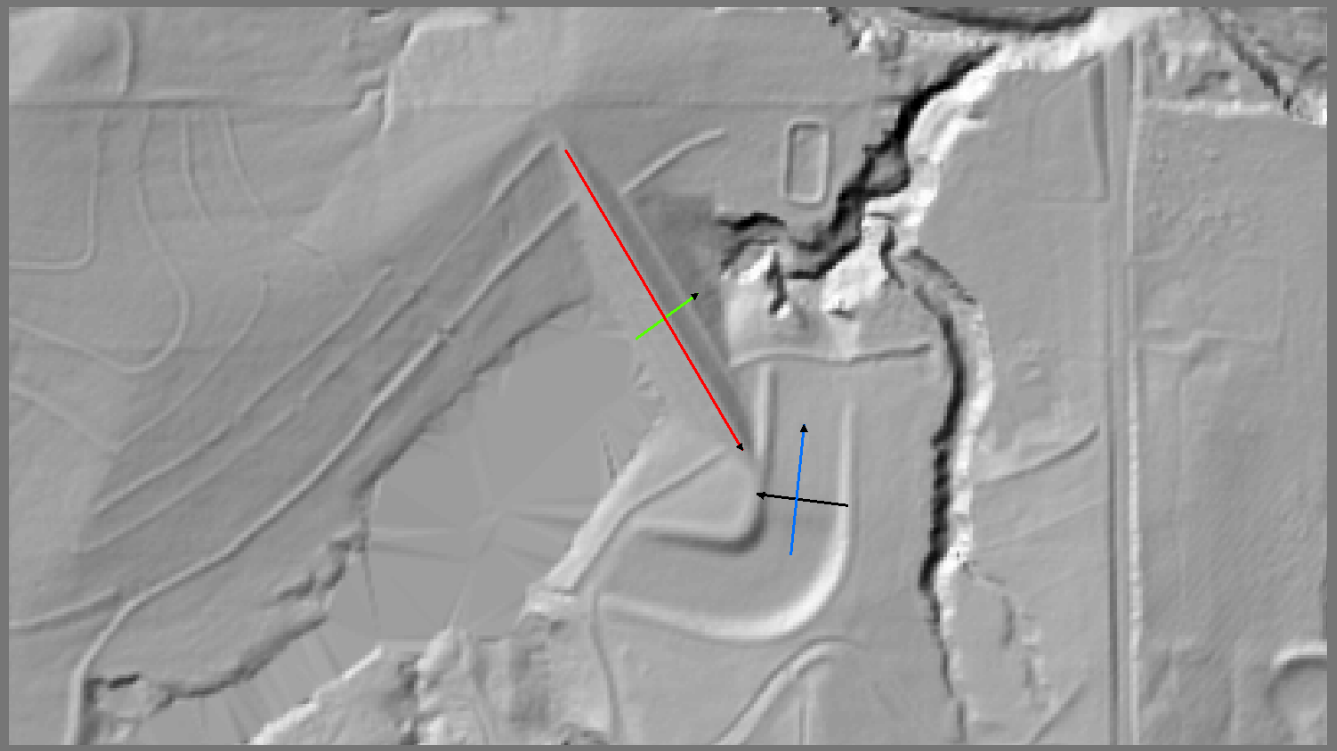
Utilize : HEC-RAS 4.1
HEC-GeoRAS 4.2
Arcview 9.3

Locate cross-sections to represent the flood plain



Watershed is modeled using the best available digital elevation model (LiDAR or 10 meter DEM)





LIDAR (**Li**ght **D**etection **A**nd **R**anging)

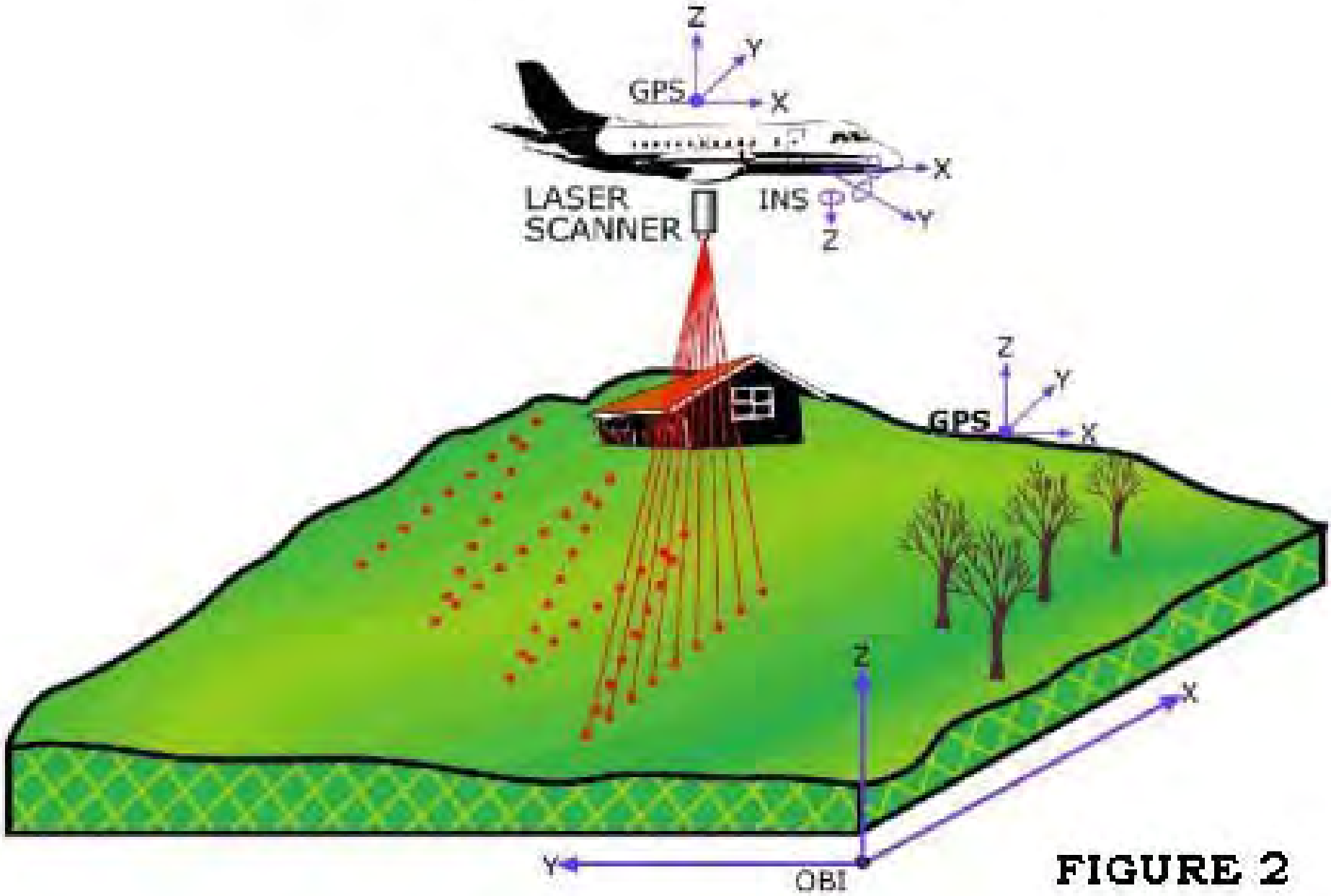
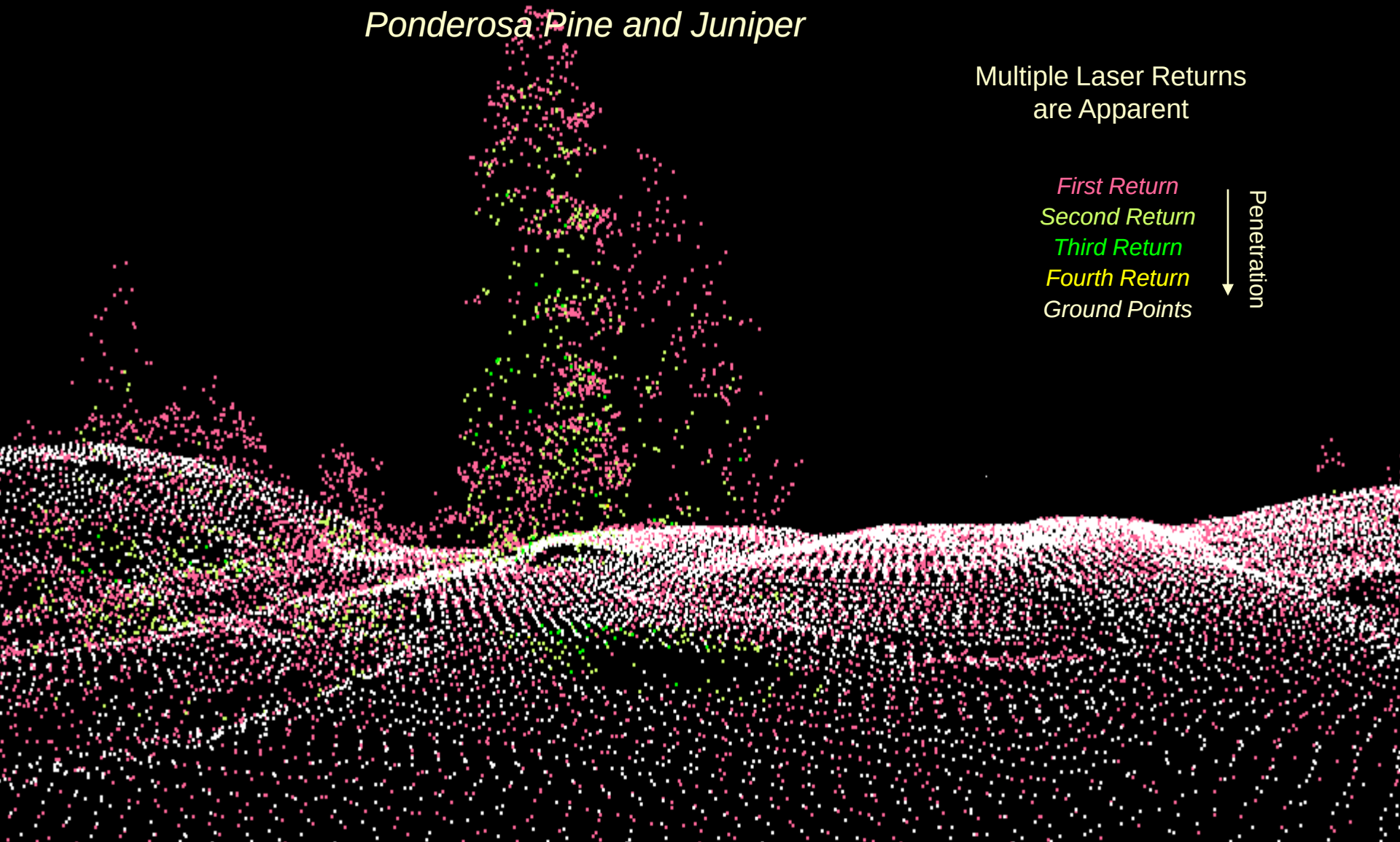


FIGURE 2

In its most basic form, LiDAR Data are points (data clouds)

Cross Section of LiDAR points

Ponderosa Pine and Juniper



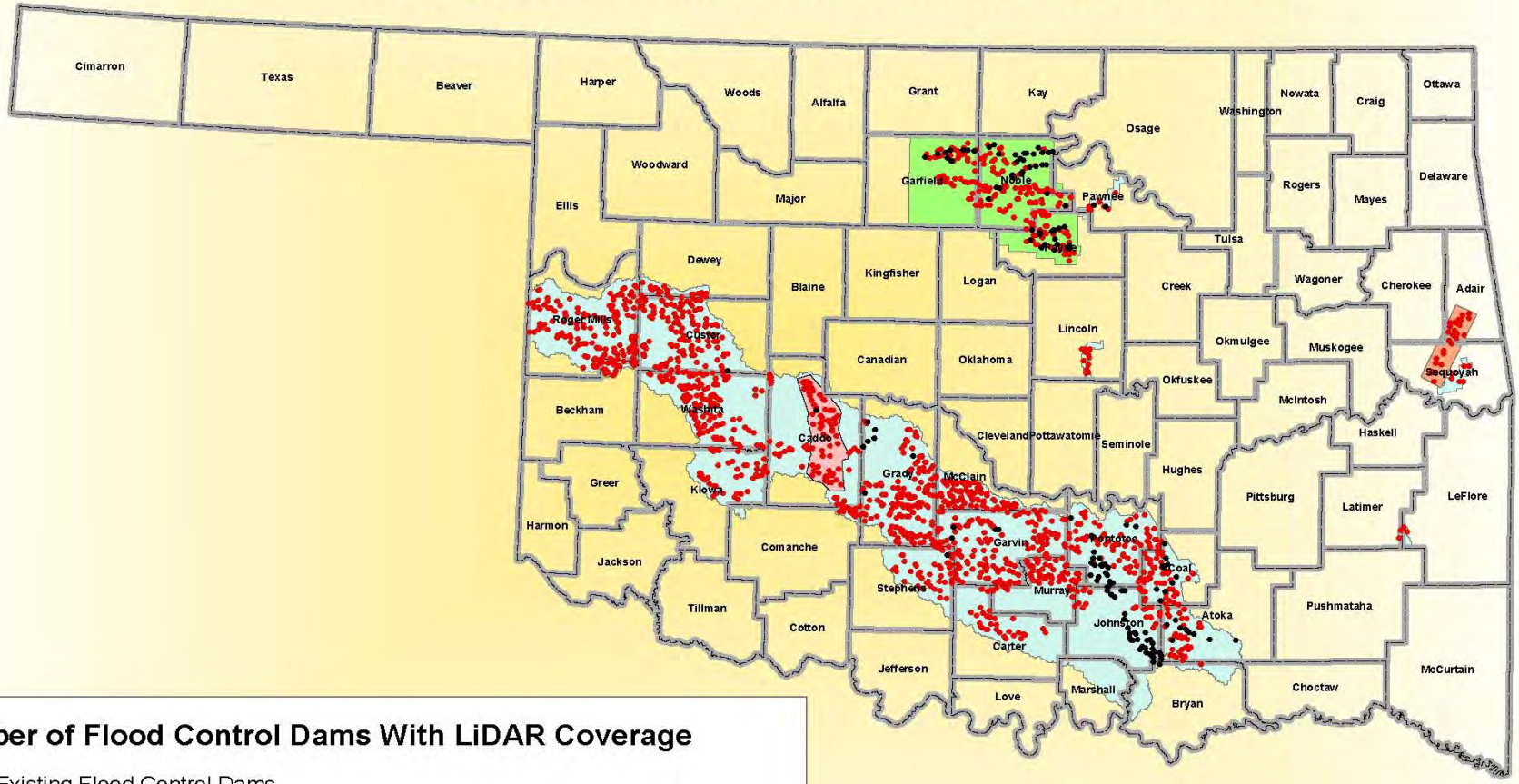
Oklahoma NRCS LiDAR Coverage

Status of Oklahoma LiDAR Projects

- 2006 2 Meter - Sallisaw Creek Project Area 188 sq. mi.
- 2008 1 Meter - Sugar Creek Project Area 342 sq. mi.
- 2010 2 Meter - Washita Drainage Plus Project Area 9,347 sq. mi.
- 2011 2 Meter - North Central Project Area 1732 sq. mi. (Available July 2011)

11,267 sq. mi.

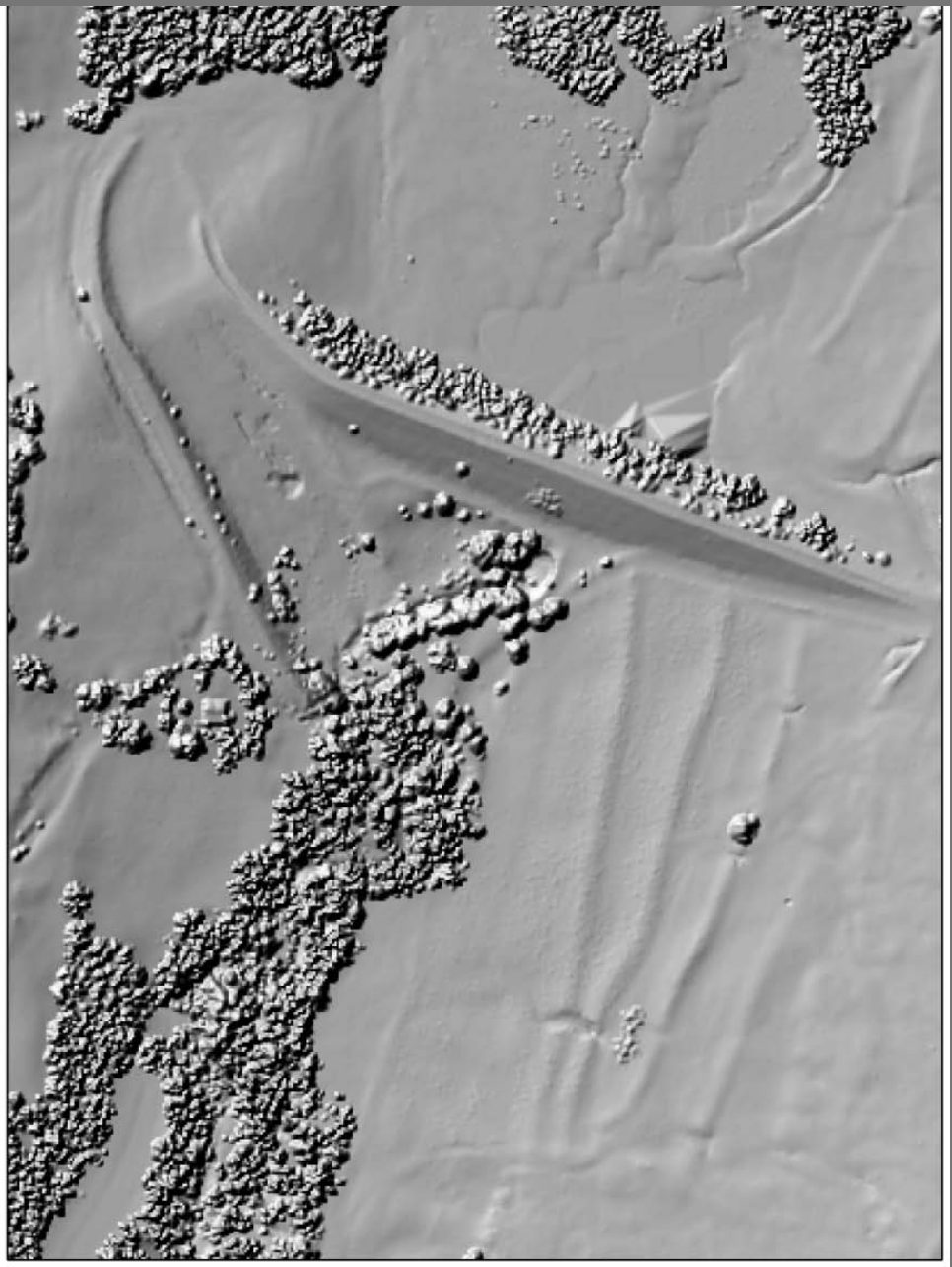
Oklahoma NRCS LiDAR Coverage Provides Detailed Elevation Information For 1502 Existing Flood Control Dams and 149 DamsThat Are Planned for Construction

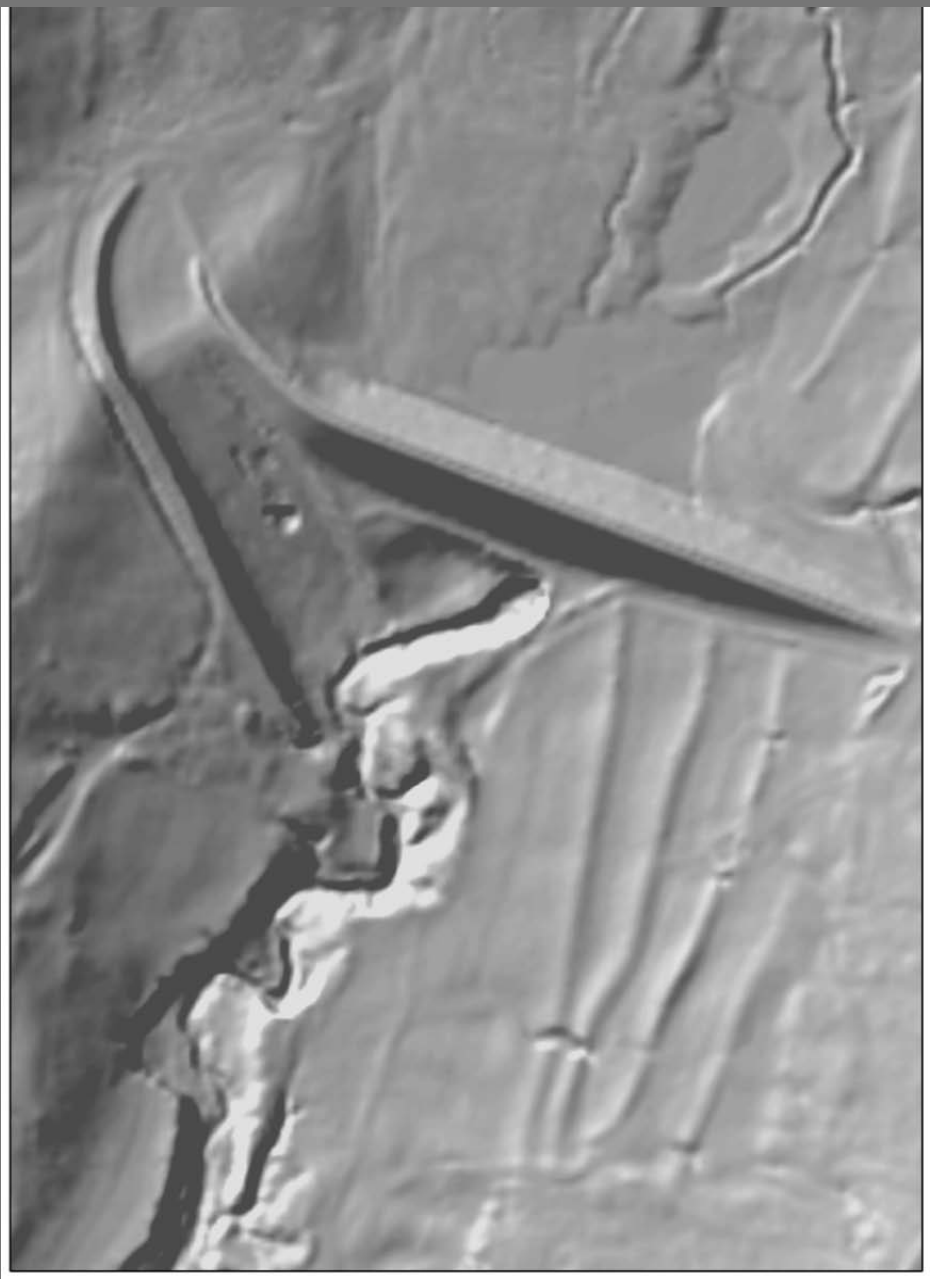


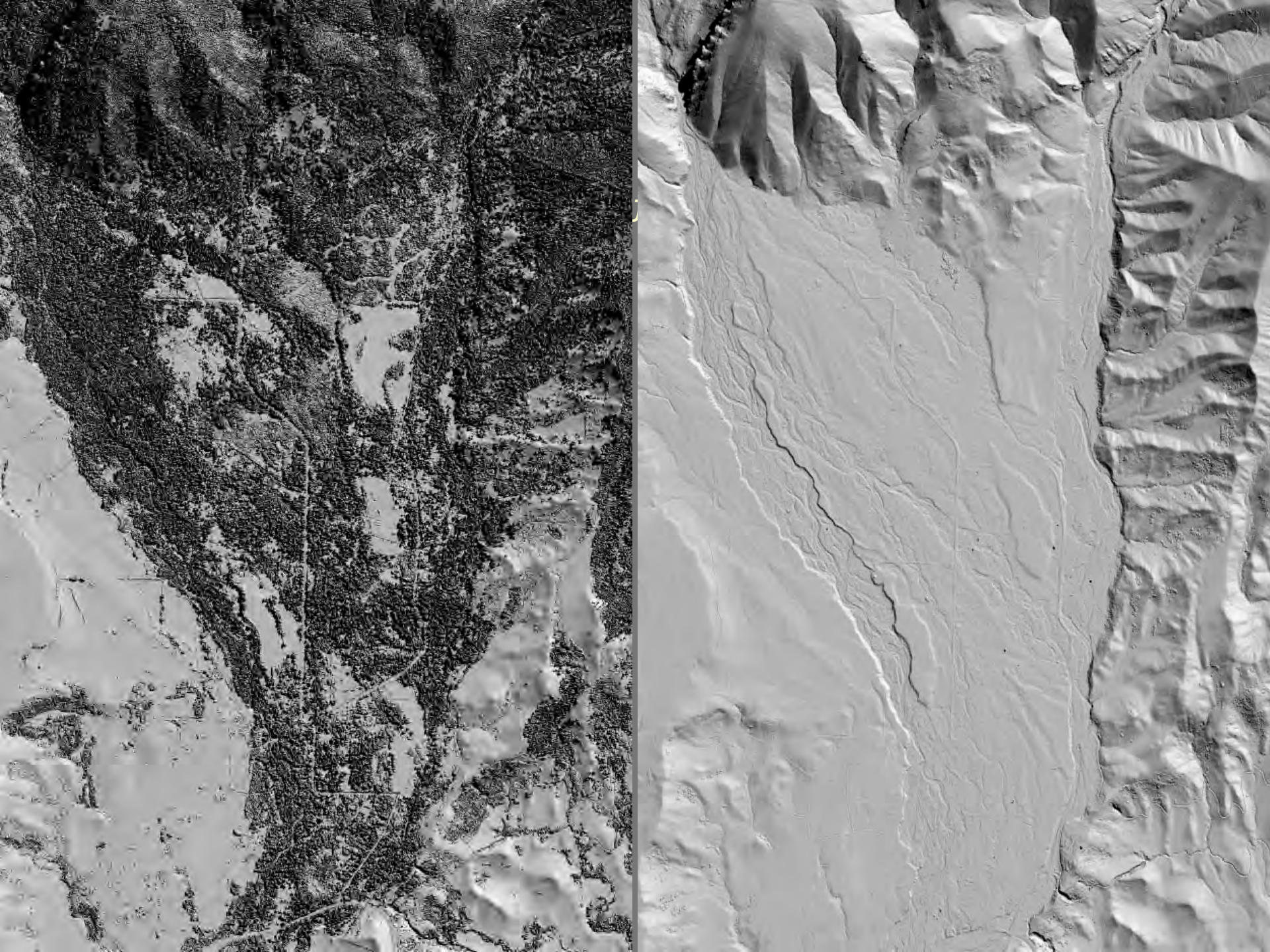
Number of Flood Control Dams With LiDAR Coverage

- Existing Flood Control Dams
- Planned Flood Control Dams
- 2011 2 Meter - North Central Project Area 170 Existing and 54 Planned
- 2006 2 Meter - Sallisaw Creek Project Area -26 Existing 0 Planned
- 2008 1 Meter - Sugar Creek Project Area - 70 Existing 1 Planned
- 2010 2 Meter - Washita Drainage Plus Project Area - 1236 Existing 94 Planned

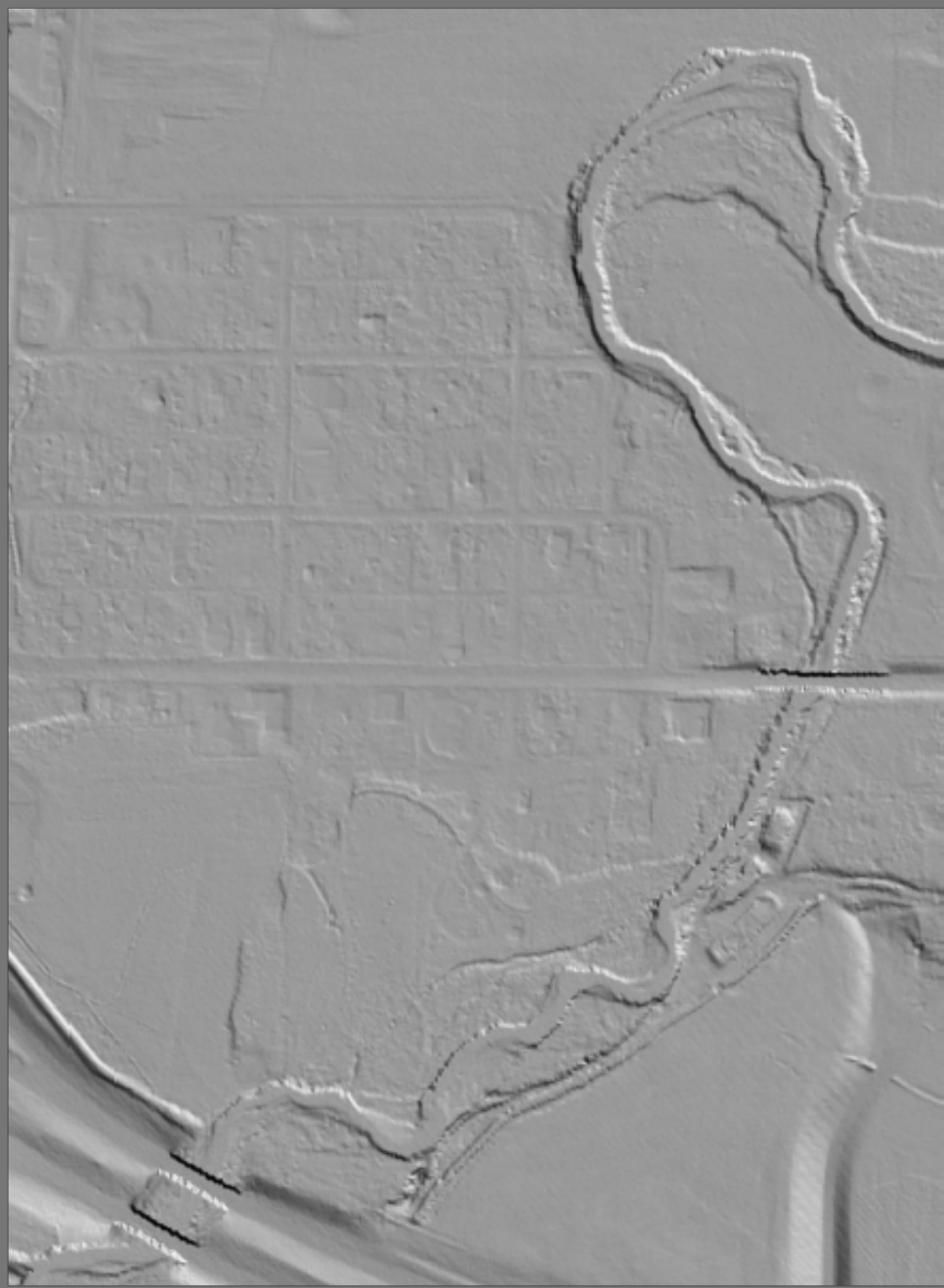
EXAMPLE FROM SALLISAW 2M LiDAR



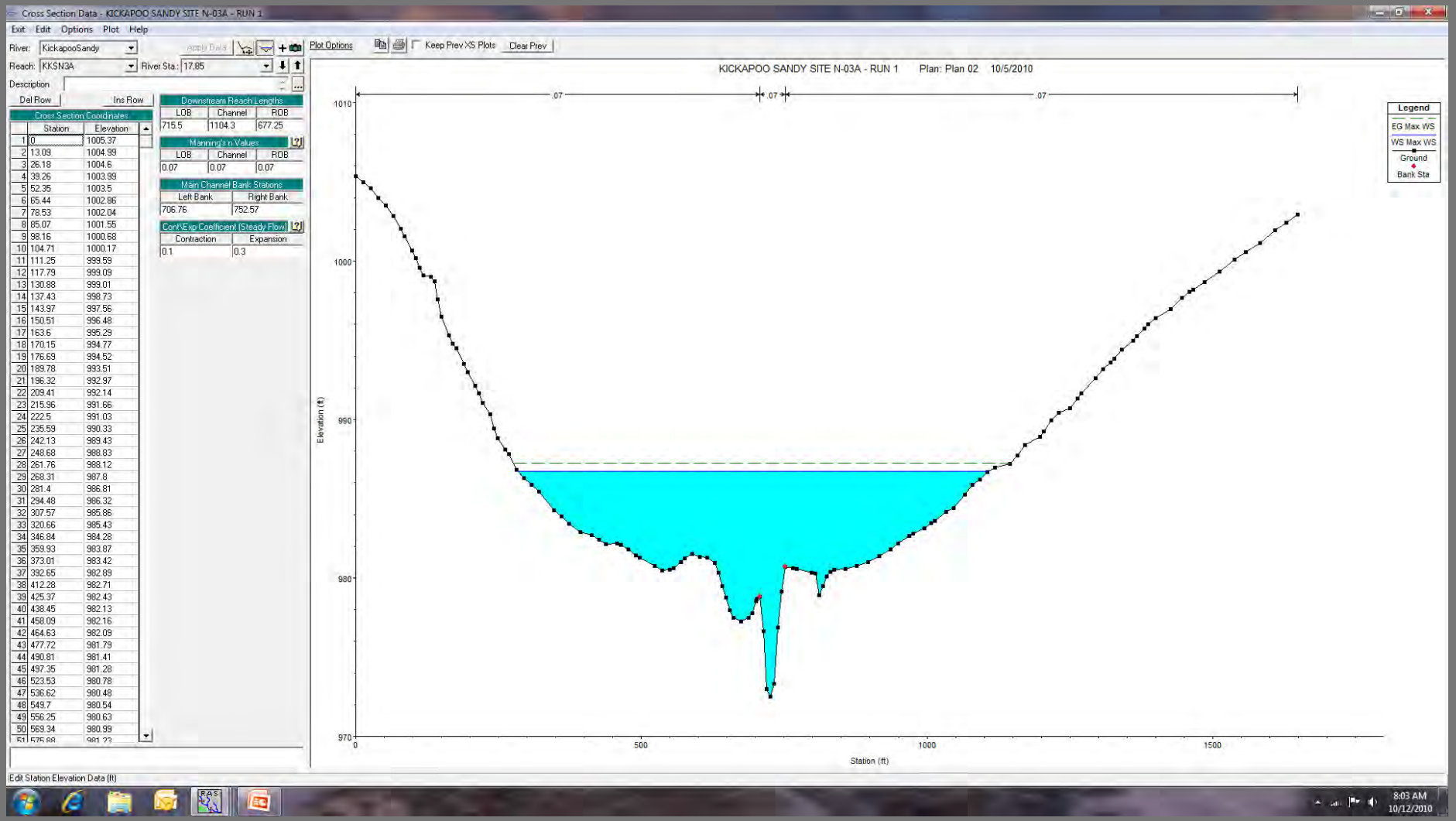




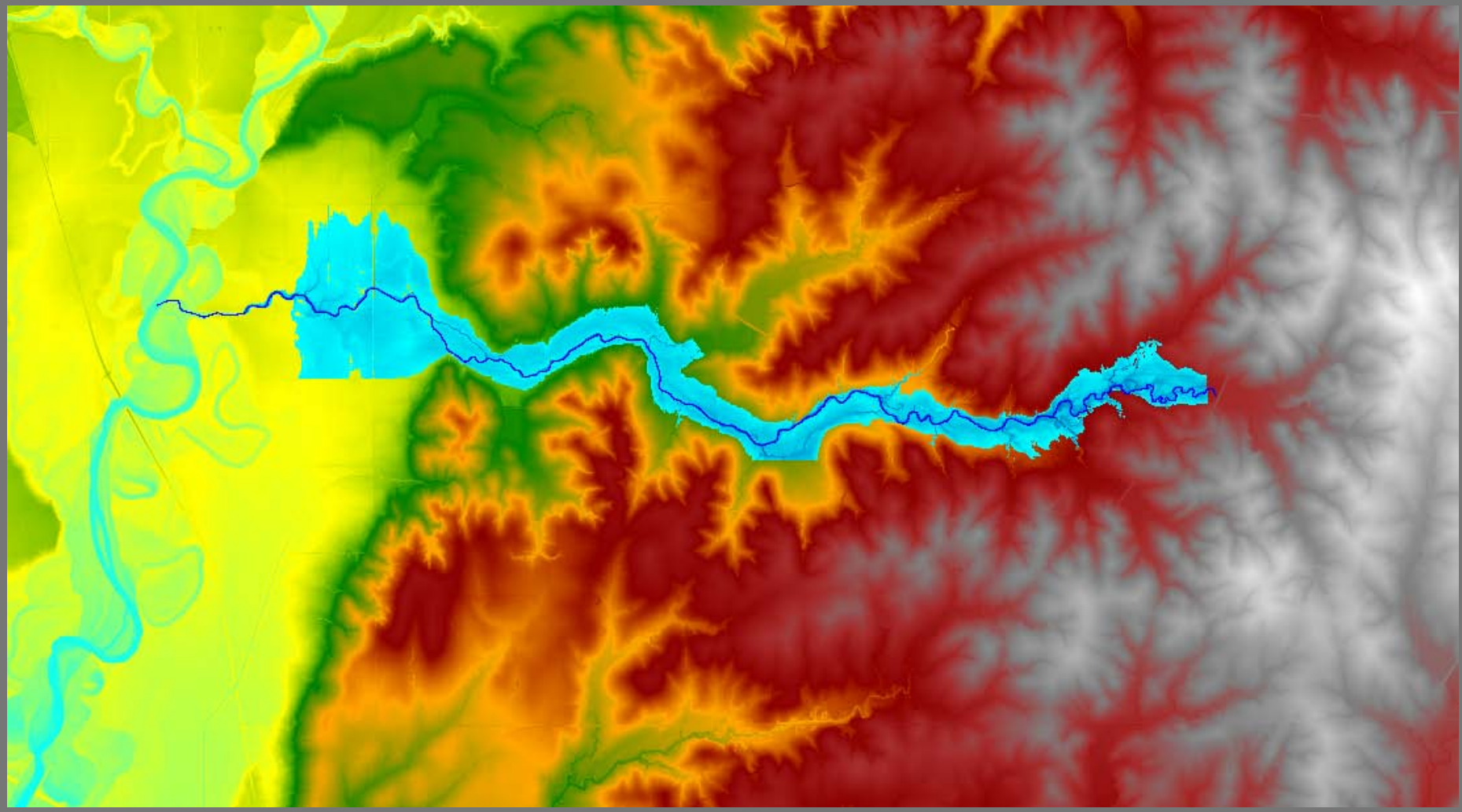
First Return Vs Bare Earth



Complete unsteady flow routing
Review elevation grids



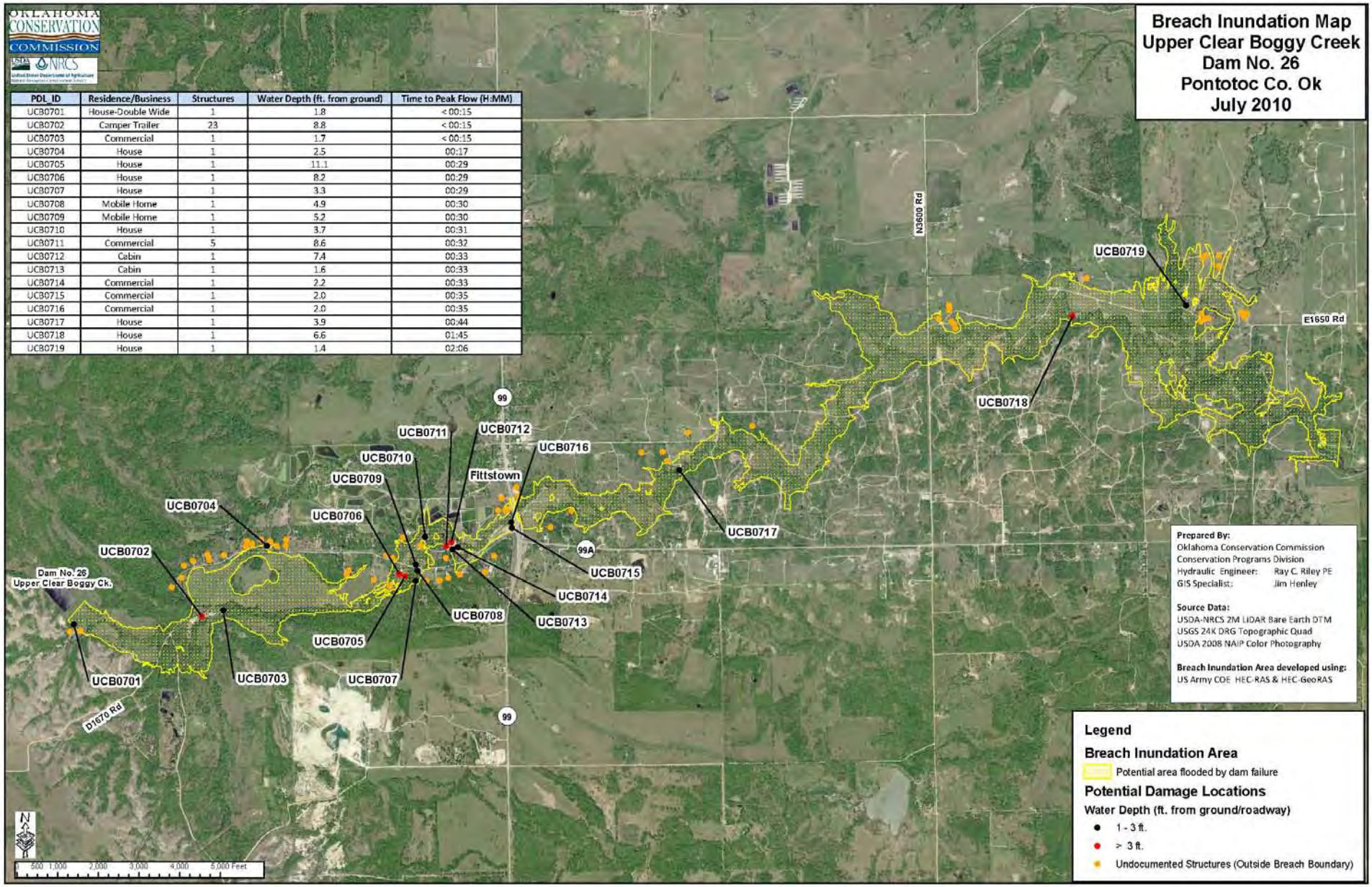
Elevations & inundation depths Are displayed using RASMapper



Shape file of the breach inundation area is superimposed on 2010 aerial photography

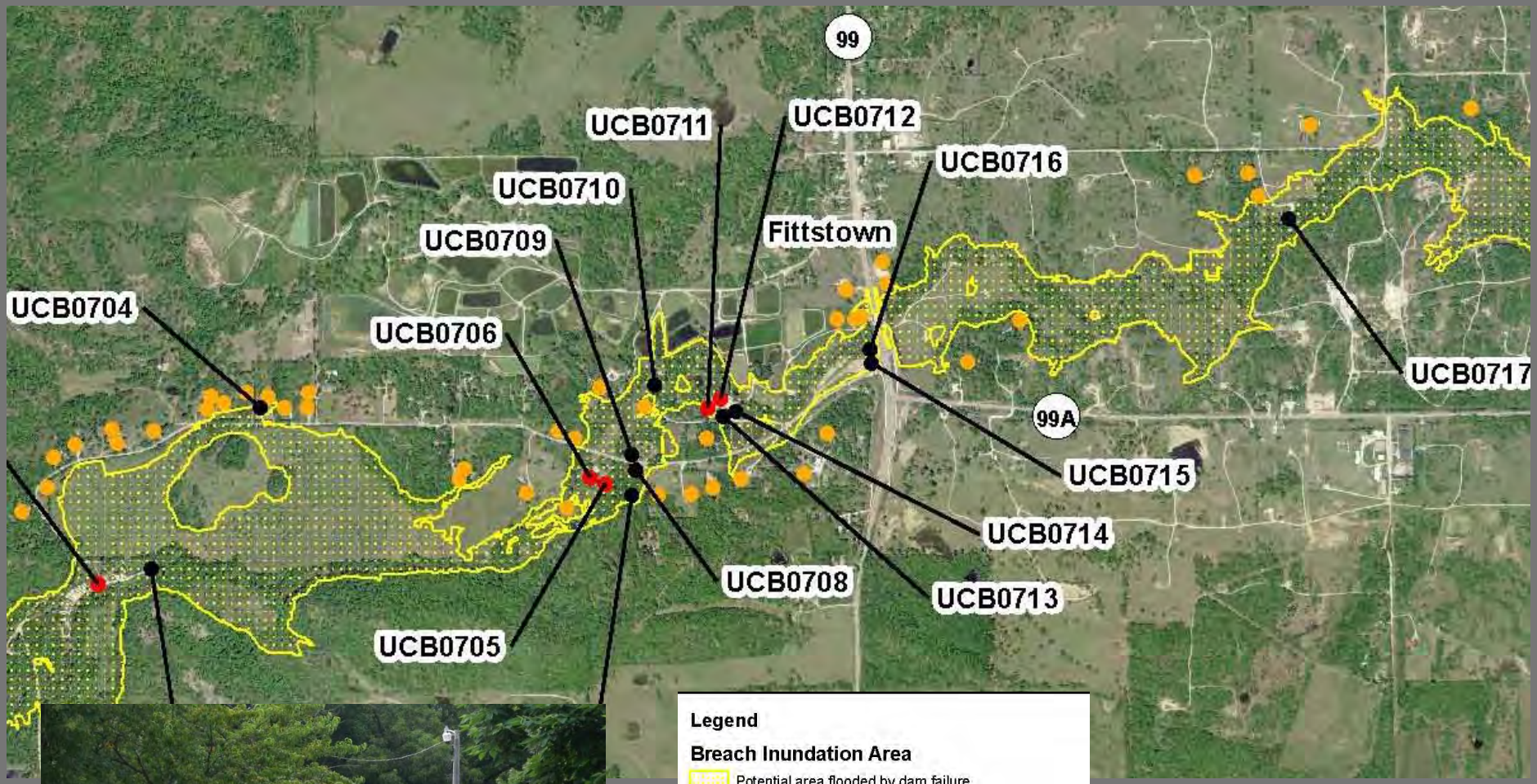
Inundation depths can be color coded

At-risk properties are located



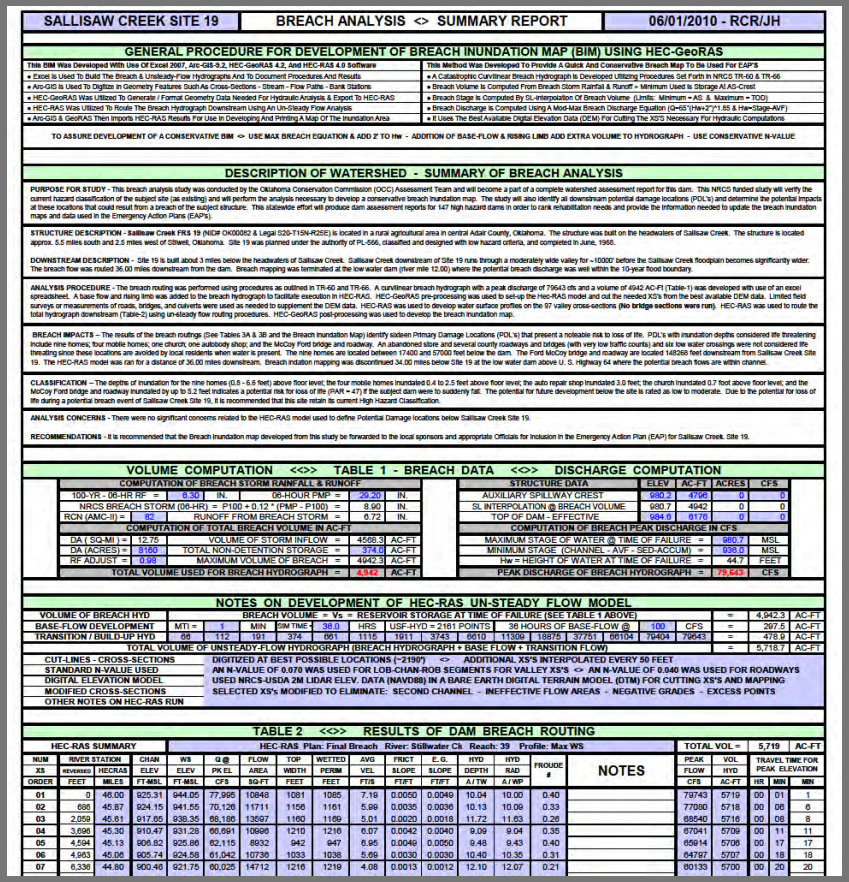
PDL_ID	Residence/Business	Structures	Water Depth (ft. from ground)	Time to Peak Flow (H:MM)
UCB0701	House-Double Wide	1	1.8	< 00:15
UCB0702	Camper Trailer	23	8.8	< 00:15
UCB0703	Commercial	1	1.7	< 00:15
UCB0704	House	1	2.5	00:17
UCB0705	House	1	11.1	00:29
UCB0706	House	1	8.2	00:29
UCB0707	House	1	3.3	00:29
UCB0708	Mobile Home	1	4.9	00:30
UCB0709	Mobile Home	1	5.2	00:30
UCB0710	House	1	3.7	00:31
UCB0711	Commercial	5	8.6	00:32
UCB0712	Cabin	1	7.4	00:33
UCB0713	Cabin	1	1.6	00:33
UCB0714	Commercial	1	2.2	00:33
UCB0715	Commercial	1	2.0	00:35
UCB0716	Commercial	1	2.0	00:35
UCB0717	House	1	3.9	00:44
UCB0718	House	1	6.6	01:45
UCB0719	House	1	1.4	02:06

At-risk properties inundation depths color coded
Each at-risk property is photographed



At-risk properties with inundation depths are tabulated

PDL_ID	Residence/Business	Structures	Water Depth (ft. from ground)	Time to Peak Flow (H:MM)
UCB0701	House-Double Wide	1	1.8	< 00:15
UCB0702	Camper Trailer	23	8.8	< 00:15
UCB0703	Commercial	1	1.7	< 00:15
UCB0704	House	1	2.5	00:17
UCB0705	House	1	11.1	00:29
UCB0706	House	1	8.2	00:29
UCB0707	House	1	3.3	00:29
UCB0708	Mobile Home	1	4.9	00:30
UCB0709	Mobile Home	1	5.2	00:30
UCB0710	House	1	3.7	00:31
UCB0711	Commercial	5	8.6	00:32
UCB0712	Cabin	1	7.4	00:33
UCB0713	Cabin	1	1.6	00:33
UCB0714	Commercial	1	2.2	00:33
UCB0715	Commercial	1	2.0	00:35
UCB0716	Commercial	1	2.0	00:35
UCB0717	House	1	3.9	00:44
UCB0718	House	1	6.6	01:45
UCB0719	House	1	1.4	02:06



SALLISAW CREEK SITE 19	BREACH ANALYSIS <> SUMMARY REPORT	06/01/2010 - RCR/JH

GENERAL PROCEDURE FOR DEVELOPMENT OF BREACH INUNDATION MAP (BIM) USING HEC-GeoRAS

This BIM Was Developed With Use Of Excel 2007, Arc-GIS 9.2, HEC-GeoRAS 4.2, And HEC-RAS 4.0 Software	This Method Was Developed To Provide A Quick And Conservative Breach Map To Be Used For EAP'S
• Excel Is Used To Build The Breach & Unsteady-Flow Hydrographs And To Document Procedures And Results	• A Catastrophic Curvilinear Breach Hydrograph Is Developed Utilizing Procedures Set Forth In NRCS TR-60 & TR-66
• Arc-GIS Is Used To Digitize In Geometry Features Such As Cross-Sections - Stream - Flow Paths - Bank Stations	• Breach Volume Is Computed From Breach Storm Rainfall & Runoff = Minimum Used Is Storage At AS-Crest
• HEC-GeoRAS Was Utilized To Generate / Format Geometry Data Needed For Hydraulic Analysis & Export To HEC-RAS	• Breach Stage Is Computed By SL-Interpolation Of Breach Volume (Limits: Minimum = AS & Maximum = TOD)
• HEC-RAS Was Utilized To Route The Breach Hydrograph Downstream Using An Un-Steady Flow Analysis	• Breach Discharge Is Computed Using A Mod-Max Breach Discharge Equation (Q=CS*(Hw+Z)^1.85 & Hw=Stage-AVF)
• Arc-GIS & GeoRAS Then Imports HEC-RAS Results For Use In Developing And Printing A Map Of The Inundation Area	• It Uses The Best Available Digital Elevation Data (DEM) For Cutting The XS'S Necessary For Hydraulic Computations

TO ASSURE DEVELOPMENT OF A CONSERVATIVE BIM <> USE MAX BREACH EQUATION & ADD 2' TO Hw - ADDITION OF BASE-FLOW & RISING LIMB ADD EXTRA VOLUME TO HYDROGRAPH - USE CONSERVATIVE N-VALUE

DESCRIPTION OF WATERSHED - SUMMARY OF BREACH ANALYSIS

PURPOSE FOR STUDY - This breach analysis study was conducted by the Oklahoma Conservation Commission (OCC) Assessment Team and will become a part of a complete watershed assessment report for this dam. This NRCS funded study will verify the current hazard classification of the subject site (as existing) and will perform the analysis necessary to develop a conservative breach inundation map. The study will also identify all downstream potential damage locations (PDL's) and determine the potential impacts at these locations that could result from a breach of the subject structure. This statewide effort will produce dam assessment reports for 147 high hazard dams in order to rank rehabilitation needs and provide the information needed to update the breach inundation maps and data used in the Emergency Action Plans (EAP's).

STRUCTURE DESCRIPTION - Sallisaw Creek FRS 19 (NID# OK00082 & Legal (S20-T15N-R25E) is located in a rural agricultural area in central Adair County, Oklahoma. The structure was built on the headwaters of Sallisaw Creek. The structure is located approx. 5.5 miles south and 2.5 miles west of Stilwell, Oklahoma. Site 19 was planned under the authority of PL-566, classified and designed with low hazard criteria, and completed in June, 1966.

DOWNSTREAM DESCRIPTION - Site 19 is built about 3 miles below the headwaters of Sallisaw Creek. Sallisaw Creek downstream of Site 19 runs through a moderately wide valley for ~10000' before the Sallisaw Creek floodplain becomes significantly wider. The breach flow was routed 36.00 miles downstream from the dam. Breach mapping was terminated at the low water dam (river mile 12.00) where the potential breach discharge was well within the 10-year flood boundary.

ANALYSIS PROCEDURE - The breach routing was performed using procedures as outlined in TR-60 and TR-66. A curvilinear breach hydrograph with a peak discharge of 79643 cfs and a volume of 4942 AC-FT (Table-1) was developed with use of an excel spreadsheet. A base flow and rising limb was added to the breach hydrograph to facilitate execution in HEC-RAS. HEC-GeoRAS pre-processing was used to set-up the Hec-RAS model and cut the needed XS's from the best available DEM data. Limited field surveys or measurements of roads, bridges, and culverts were used as needed to supplement the DEM data. HEC-RAS was used to develop water surface profiles on the 97 valley cross-sections **(no bridge sections were run)**. HEC-RAS was used to route the total hydrograph downstream (Table-2) using un-steady flow routing procedures. HEC-GeoRAS post-processing was used to develop the breach inundation map.

BREACH IMPACTS – The results of the breach routings (See Tables 3A & 3B and the Breach inundation Map) identify sixteen Primary Damage Locations (PDL's) that present a noteable risk to loss of life. PDL's with inundation depths considered life threatening include nine homes, four mobile homes, one church, one autobody shop, and the McCoy Ford bridge and roadway. An abandoned store and several county roadways and bridges (with very low traffic counts) and six low water crossings were not considered life threating since these locations are avoided by local residents when water is present. The nine homes are located between 17400 and 57000 feet below the dam. The Ford McCoy bridge and roadway are located 148268 feet downstream from Sallisaw Creek Site 19. The HEC-RAS model was ran for a distance of 36.00 miles downstream. Breach inidation mapping was discontinued 34.00 miles below Site 19 at the low water dam above U. S. Highway 64 where the potential breach flows are within channel.

CLASSIFICATION – The depths of inundation for the nine homes (0.8 - 5.6 feet) above floor level; the four mobile homes inundated 0.4 to 2.5 feet above floor level; the auto repair shop inundated 3.0 feet; the church inundated 0.7 foot above floor level; and the McCoy Ford bridge and roadway inundated by up to 5.2 feet indicates a potential risk for loss of life (PAR = 47) if the subject dam were to suddenly fail. The potential for future development below the site is rated as low to moderate. Due to the potential for loss of life during a potential breach event of Sallisaw Creek Site 19, it is recommended that this site retain its current High Hazard Classification.

ANALYSIS CONCERNS - There were no significant concerns related to the HEC-RAS model used to define Potential Damage locations below Sallisaw Creek Site 19.

RECOMMENDATIONS - It is recommended that the Breach Inundation map developed from this study be forwarded to the local sponsors and appropriate Officials for inclusion in the Emergency Action Plan (EAP) for Sallisaw Creek. Site 19.

VOLUME COMPUTATION <<>> TABLE 1 - BREACH DATA <<>> DISCHARGE COMPUTATION

COMPUTATION OF BREACH STORM RAINFALL & RUNOFF					
100-YR - 06-HR RF =	8.30	IN.	06-HOUR PMP =	29.20	IN.
NRCS BREACH STORM (06-HR) = P100 + 0.12 * (PMP - P100) =				8.90	IN.
RCN (AMC-II) =	82		RUNOFF FROM BREACH STORM =	6.72	IN.

COMPUTATION OF TOTAL BREACH VOLUME IN AC-FT			
DA (SQ-MI) =	12.75	VOLUME OF STORM INFLOW =	4566.3 AC-FT
DA (ACRES) =	8160	TOTAL NON-DETENTION STORAGE =	374.0 AC-FT
RF ADJUST =	0.98	MAXIMUM VOLUME OF BREACH =	4942.3 AC-FT
		TOTAL VOLUME USED FOR BREACH HYDROGRAPH =	4,942 AC-FT

STRUCTURE DATA	ELEV	AC-FT	ACRES	CFS
AUXILIARY SPILLWAY CREST	980.2	4796	0	0
SL INTERPOLATION @ BREACH VOLUME	980.7	4942	0	0
TOP OF DAM - EFFECTIVE	984.6	8176	0	0

COMPUTATION OF BREACH PEAK DISCHARGE IN CFS		
MAXIMUM STAGE OF WATER @ TIME OF FAILURE =	980.7	MSL
MINIMUM STAGE (CHANNEL - AVF - SED-ACCUM) =	936.0	MSL
Hw = HEIGHT OF WATER AT TIME OF FAILURE =	44.7	FEET
PEAK DISCHARGE OF BREACH HYDROGRAPH =	79,643	CFS

NOTES ON DEVELOPMENT OF HEC-RAS UN-STEADY FLOW MODEL

VOLUME OF BREACH HYD	BREACH VOLUME = Vs = RESERVOIR STORAGE AT TIME OF FAILURE (SEE TABLE 1 ABOVE)											=	4,942.3	AC-FT
BASE-FLOW DEVELOPMENT	MTI =	5	MIN	SIM TIME =	36.0	HRS	USF-HYD = 2161 POINTS	36 HOURS OF BASE-FLOW @	100	CFS		=	297.5	AC-FT
TRANSITION / BUILD-UP HYD	66	112	191	374	661	1115	1911	3743	6610	11309	18876	37751	66104	79404	79643	=	478.9	AC-FT
TOTAL VOLUME OF UNSTEADY-FLOW HYDROGRAPH (BREACH HYDROGRAPH + BASE FLOW + TRANSITION FLOW)																=	5,718.7	AC-FT

CUT-LINES - CROSS-SECTIONS	DIGITIZED AT BEST POSSIBLE LOCATION$ (~2190') <> ADDITIONAL XS'S INTERPOLATED EVERY 50 FEET
STANDARD N-VALUE USED	AN N-VALUE OF 0.070 WAS USED FOR LOB-CHAN-ROB SEGMENTS FOR VALLEY XS'S <> AN N-VALUE OF 0.040 WAS USED FOR ROADWAYS
DIGITAL ELEVATION MODEL	USED NRCS-USDA 2M LIDAR ELEV. DATA (NAVD88) IN A BARE EARTH DIGITAL TERRAIN MODEL (DTM) FOR CUTTING XS'S AND MAPPING
MODIFIED CROSS-SECTIONS	SELECTED XS's MODIFIED TO ELIMINATE: SECOND CHANNEL - INEFFECTIVE FLOW AREAS - NEGATIVE GRADES - EXCESS POINTS
OTHER NOTES ON HEC-RAS RUN	

TABLE 2 <<>> RESULTS OF DAM BREACH ROUTING

HEC-RAS SUMMARY — HEC-RAS Plan: Final Breach River: Stillwater Ck Reach: 39 Profile: Max WS — TOTAL VOL = 5,719 AC-FT

NUM XS ORDER	RIVER STATION REVERSED FEET	CHAN HECRAS MILES	WS ELEV FT-MSL	G @ PK EL FT-MSL	FLOW AREA CFS	TOP WIDTH SQ-FT	WETTED PERIM FEET	AVG VEL FEET	FRICT SLOPE FT/FT	E.G. SLOPE FT/FT	HYD DEPTH A / TW	HYD RAD A / WP	FROUDE #	NOTES	PEAK FLOW CFS	VOL HYD AC-FT	TRAVEL TIME FOR PEAK ELEVATION HR	MIN	MIN
01	0	46.00	925.31	944.05	77,995	10848	1081	1085	7.19	0.0050	0.0049	10.04	10.00	0.40		79743	5719	00	01	1
02	699	45.87	924.15	941.55	70,126	11711	1156	1161	5.99	0.0035	0.0036	10.13	10.09	0.33		77090	5718	00	06	6
03	2,059	45.61	917.65	938.35	66,186	13597	1160	1169	5.01	0.0020	0.0018	11.72	11.63	0.26		68540	5716	00	08	8
04	3,696	45.30	910.47	931.28	66,691	10996	1210	1216	6.07	0.0042	0.0040	9.09	9.04	0.35		67041	5709	00	11	11
05	4,594	45.13	906.82	925.86	62,115	8932	942	947	6.95	0.0049	0.0050	9.48	9.43	0.40		65914	5708	00	17	17
06	4,963	45.06	905.74	924.58	61,042	10736	1033	1038	5.69	0.0030	0.0030	10.40	10.35	0.31		64797	5707	00	18	18
07	6,336	44.80	900.46	921.75	60,025	14712	1216	1219	4.08	0.0013	0.0012	12.10	12.07	0.21		60133	5700	00	20	20

Detailed documentation of breach analysis

Population at Risk & Risk Index Ranking

Population at Risk (PAR)

The population at risk (PAR) value is based on the number of inhabitable structures and businesses potentially impacted by a breach of the dam and the number of people that would be at risk while driving on a road that is overtopped by the breach flow.

The PAR for habitable structures was computed as follows:

4 Mobile homes with inundation depths >2 feet above natural ground @ 2.6 PAR = 10
9 Houses with inundation depths >1 foot above natural ground @ 2.6 PAR = 23
1 Church with inundation depths >1 foot above natural ground @ 5.0 PAR = 5
1 Commercial building with inundation depths >1 foot above natural ground @ 5.0 PAR = 5

The PAR for roads was computed as follows:

Ford McCoy Road with overflow depths >1 foot, 2 vehicles @ 2 PAR = 4

Total PAR = 47

Failure and Risk Index Computations

The failure and risk index spreadsheets can be found in Appendix 6. Input was based on design parameters, as-built conditions and the PARs summarized above.

Any structure inundated by the breach wave greater than one foot above natural ground (two feet for mobile homes) was considered at risk for the static and hydrologic failure conditions.

For the seismic condition, it was assumed that the maximum breach water surface elevation would be one foot lower than the maximum breach shown in the breach analysis. Therefore, any structure inundated by more than two feet was considered to be at-risk for the seismic condition.

The warning time for failure was determined to be less than 60 minutes since it was assumed that there is a current emergency action plan in place and the at-risk has a vague understanding of the risk involved. The fatality rates were then determined by the standard risk procedures.

The failure index was computed to be 182 and risk index was computed to be 342.

EVALUATION OF POTENTIAL REHABILITATION PROJECTS

STATE	OK	DAM	Sallisaw Creek, Site No. 19		BY	lwc	DATE	6/8/10	
		YEAR BUILT	1968	DESIGN HAZARD CLASS	L	DRAINAGE AREA		12.75	mi2
		WORK PLAN DATE	1961	CURRENT HAZARD CLASS	H	DAM HEIGHT		61	ft
sht 1 of 5			CONSEQUENCES OF DAM FAILURE					ver 100101	

POTENTIAL DAM FAILURE:				
Total Failure Index			182	A
POTENTIAL LOSS OF LIFE:				
Maximum Population-at-Risk [PAR]		(number)	47	B
Total Risk Index			342	C
POTENTIAL LOSS OF PROPERTY:				
Identify major community affected by breach and rate impact as High (H), Medium (M), Low (L) or None(blank)				
Community Bunch		(H,M,L,-)	H	D
Number of homes, businesses, major buildings		(number)	15	E
POTENTIAL LIFELINE DISRUPTION:				
Water supply, identify community disrupted by dam failure, and estimate number/amount				
Municipal sole source	Users	(number)	0	F
Supplemental source	Users	(number)	0	G
Irrigation water	Storage	(Ac-Ft)	0	H
POTENTIAL INFRASTRUCTURE DISRUPTION:				
Transportation system crossings, identify major crossing rendered unusable by dam failure, and estimate number				
Major/Interstate	Roads	(number)	0	I
Secondary/County	Roads	(number)	0	J
POTENTIAL ADVERSE IMPACTS ON THE ENVIRONMENT:				
Describe impacts and rate each as High (H), Medium (M), Low (L), or None (blank)				
Threatened & endangered species		(H,M,L,-)	L	K
Sensitive riparian areas		(H,M,L,-)	L	L
Contaminated reservoir sediment		(H,M,L,-)	-	M
Wetland and wildlife habitat		(H,M,L,-)	L	N
Other		(H,M,L,-)	-	O
POTENTIAL ADVERSE SOCIAL IMPACTS:				
Describe impacts and rate each as High (H), Medium (M), Low (L) or None(blank)				
Known cultural resources		(H,M,L,-)	M	P
Historic preservation issues		(H,M,L,-)	L	Q
Socially disadvantaged community Bunch		(H,M,L,-)	H	R
POTENTIAL ADVERSE ECONOMIC IMPACTS:				
Average annual benefits attributed to this dam, updated workplan value		($)	195,828	S
Changes in benefits since workplan; Increase(I), No change(NC), Decrease(D)		(I,NC,D)	NC	T
Low income families impacted		(number)	10	U
INPUT BY STATE DAM SAFETY AGENCY:				
State dam safety order issued for repair, modification, removal issued, Yes(Y), No(N)		(Y,N)	N	V
State Dam Safety Agency Priority, High(H), Medium(M), Low(L), None(blank)		(H,M,L,-)	H	W
OTHER CONSIDERATIONS:				
Identify any other considerations and rate as High(H), Medium(M), Low(L) or None(blank)				
		(H,M,L,-)		X
		(H,M,L,-)		Y

Rehabilitation Alternatives:
All the following cost estimates should be considered as preliminary "order of magnitude" cost estimates. Actual low bid costs of rehabilitated dams in Oklahoma were analyzed to determine costs for various components of the dams based on site-specific conditions.
Site specific data (drainage area, stage storage curve, sediment storage delivery rates, etc.) was used as the basis for determining viable alternatives for rehabilitating the dam to current design standards.

The planned sediment delivery rate was compared to age of the dam and observations at the site to subjectively determine if they were reasonable (an-on-site sediment survey was not conducted). The sediment storage requirements for 100 years were then calculated to determine the new principal spillway elevation and the amount of aerated sediment to be deducted from the detention storage. The time of concentration was calculated from GIS data for the specific drainage area.

The NRCS SITES software was used to determine the flood detention requirements and the corresponding auxiliary spillway elevation for a range of conduit sizes. The conduit diameter(s) deemed most appropriate for both site and downstream conditions was selected for use in determining the auxiliary spillway crest elevation. The NRCS SITES program was again used with PMP freeboard requirements to determine a range of auxiliary spillway widths and associated top of dam elevations.

The structural alternatives will usually consist of one or two principal spillway pipe sizes and the corresponding elevation and width of the auxiliary spillway and corresponding top of dam. Other alternatives, such as decommissioning, relocating downstream at-risk properties, and a structural spillway over the embankment were determined as appropriate for the specific site conditions.

For this dam, the following rehabilitation alternatives are proposed to be considered:

Alternative 1:
- Raise the principal spillway inlet elevation 4.9 feet to provide an additional 100 years of sediment storage
- Lower the auxiliary spillway elevation 1.0 feet
- Raise the top of dam elevation 5.5 feet
- Bore and jack a new 54-inch principal spillway; abandon existing 30-inch principal spillway
- Widen the auxiliary spillway from 200 feet to 400 feet

Alternative 2:
- Raise the principal spillway inlet elevation 4.9 feet to provide an additional 100 years of sediment storage
- Lower the auxiliary spillway elevation 2.2 feet
- Raise the top of dam elevation 4.4 feet
- Bore and jack a new 60-inch principal spillway; abandon existing 30-inch principal spillway
- Widen the auxiliary spillway from 200 feet to 400 feet

Alternative 3:
Construct a roller compacted concrete (RCC) spillway over the embankment to replace the existing vegetated auxiliary spillway and provide the needed added capacity. Include rock riprap protection at the outlet.

Determine alternatives to meet current criteria

1. Rebuild Dam
2. Relocate at-risk properties
3. Decommission

Approximate Rehabilitation Costs

All the following cost estimates should be considered as preliminary "order of magnitude" cost estimates. They are based upon actual costs of similar rehabilitation projects that have been recently designed and constructed. Actual low bid costs of rehabilitated dams in Oklahoma were analyzed to determine costs for various components of the dams based on site-specific conditions.

Costs for the following components are estimated, principal spillway conduit, earth fill, excavation, rock riprap, drainage systems, vegetation, mobilization, fencing, and concrete. A spreadsheet was developed to use site-specific data (width of valley, height of dam, disturbed area, etc.) and the rehabilitation alternatives determined (elevation and size of principal spillway, elevation and width of auxiliary spillway, etc.). Note, these cost estimates do not include costs for land rights or local sponsor project management, etc. It is assumed that a detailed design alternative analysis or value engineering phase will occur during the planning phase and a more detailed cost estimate will be completed at that time. These costs are based upon 2010 dollars and should be inflated accordingly to determine the estimated cost of these improvements in future years.

The following are the estimated costs for the alternatives described above:

	Existing Dam	Alternative #1	Alternative #2	Alternative #3 RCC Spillway
Top of Dam Elevation	984.6	990.1	989.0	991.7
Auxiliary Spillway Elevation	980.2	979.2	978.0	978.0
Principal Spillway Elevation	948.2	953.1	953.1	953.1
Principal Spillway Diameter (in.)	30	54	60	60
Auxiliary Spillway Width (ft.)	200	400	400	250
Estimated Cost		$3,040,000	$2,800,000	$7,550,000

In order to meet OWRB criteria, the top of dam will need to be raised 5.5 feet assuming one foot of freeboard is required.

Relocating downstream at-risk properties and rehabilitating the dam to low hazard criteria and decommissioning the existing dam were found to not be viable alternatives for this dam.

Cost estimates for rehabilitation alternatives

Rehabilitation Assessment Report

Sallisaw Creek Watershed
Dam No. 19

Adair County, Oklahoma
Adair County Conservation District
NID No. OK00082

Population at Risk: 47
Dam Failure Index: 182
Risk Index: 342
Current Hazard Classification: High

Oklahoma Conservation Commission
USDA Natural Resources Conservation Service
October 2010

OKLAHOMA CONSERVATION COMMISSION

NRCS

Final assessment report is distributed to the conservation district

Current Status

- 36 reports have been distributed to 12 CDs
- 30 reports will be going out soon to 7 CDs
- 18 reports will go out within the next month to 1 CD
- Remaining 63 reports will be distributed to 25 CDs prior to September

“Next Steps” when sponsors receive their assessment report(s):

- Request OCC funding for recommended O&M items. Special attention to “urgent” actions needed

- Update emergency action plans with new breach inundation map and at-risk properties

“Next Steps” when sponsors receive their assessment report(s):

- Identify dams with most critical rehabilitation needs and submit application for federal assistance SF-424 and make funding request

- NRCS and project sponsors work on planning, design and construction of funded rehabilitation projects

Oklahoma's Strong Watershed Partnership

Private, Local, State, Federal


OKLAHOMA
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