ORIGINAL

IN THE SUPREME COURT OF OHIO

STATE OF OHIO EX REL. WAYNE T. DONER, ET AL.,	:	Case No. 2009-1292
Relators,	:	Original Action in Mandamus
v.	:	
JAMES ZEHRINGER, DIRECTOR, OHIO DEPARTMENT OF NATURAL RESOURCES, ET AL.,	:	
Respondents.	:	

RESPONDENTS' CROSS-MOTION FOR LEAVE TO FILE ITS OWN SUPPLEMENT TO EVIDENCE

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MEMORANDUM IN SUPPORT

On April 24, 2014, Relators filed a *Motion for Leave to File Supplement to Evidence*. In conformance with this Court's April 25, 2014 *Entry*, ODNR timely filed a *Memorandum in Response* to Relators' *Motion* on April 28, 2014. Should this Court grant Relators' *Motion for Leave*, ODNR likewise respectfully requests that this *Cross-Motion for Leave to File Its Own Supplement to the Evidence* be granted. ODNR recently filed in the trial court a *Motion for Leave to File an Amended Petition* in *ODNR v. The John H. Zumberge Trust UAD 1990, et al.*, Mercer C.P. No 13-CIV-083 ("*Zumberge*") (attached hereto as Exhibit 1). In the *Zumberge Petition*, like in the *Karr Petition* discussed in Relators' *Motion for Leave* and ODNR's associated *Memorandum in Response*, ODNR pleads in the alternative by again presenting the trial court with two options. First, in Count I of the proposed *Amended Petition*, ODNR requests that the trial court allow it to appropriate a flowage easement over the subject property based upon a 10-year flood event. To demonstrate the boundary lines of the 10-year flood event-based flowage easement, ODNR then attached an exhibit depicting the easement.

Second, in Count II of the proposed *Amended Petition* (just as it did in *Karr*) ODNR alleges, "in the event [the trial court] dismisses Count I or otherwise determines in this case as it did in *Thomas*, *Powell*, and *Knapke* that the post-appropriation extent of the take for valuation purposes is the 2003 flood line, the 2003 flood line-based flowage easement to be appropriated in this case is that described in Exhibit B...." ODNR then attached an exhibit that depicted the boundary lines of the 2003 flood event-based flowage easement. As one might expect, because the property that is the subject of the *Zumberge Petition* is located much closer to the spillway than the *Karr* property, the appropriated easement interest is much larger in terms of geographic area, frequency, and duration.

As evidenced by the attached *Zumberge Motion to Amend* and proposed *Amended Petition*, clearly Relators have mischaracterized both ODNR's hydrological analysis and their plans for amending all petitions going forward. The hydrological analysis utilized by ODNR quantifies, with scientific precision, the extent of the taking on each and every property involved in this litigation. While Relators would prefer this Court only review parcels several miles from the spillway that have marginal increases in flooding, like the increase set forth in the 10-year flood event in the *Karr* petition (a property located approximately 10 miles away from the spillway), the *Zumberge Petition,* involving property located ½ mile from the spillway, reveals, not surprisingly, that the increase in flooding is far more pronounced the closer a given parcel is to the spillway. Accordingly, to the extent this Court grants Relators' *Motion for Leave to File Supplement to Evidence*, ODNR respectfully requests that this Court likewise grant its *Motion for Leave to File Its Own Supplement to Evidence* such that a true and accurate determination can be made on the merits of Relators' *Show Cause Motion.*

Respectfully submitted,

Scott Phillips by [signature] (per authority 0073758) (Kevin T. Shook)

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PROOF OF SERVICE

I hereby certify that a copy of Respondents' Cross-Motion for Leave to File Its Own Supplement to Evidence was served by electronic and ordinary U.S. mail on April 28, 2014 on the counsel listed below:

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IN THE COURT OF COMMON PLEAS
MERCER COUNTY, OHIO

STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES,	:	**CASE NO.: 13-CIV-083**
Plaintiff,	:	**Judge Jeffrey R. Ingraham**
v.	:	
THE JOHN H. ZUMBERGE TRUST UAD 1990, ***et al.*,**	:	
Defendants.	:	

MOTION FOR LEAVE TO FILE SECOND AMENDED PETITION TO APPROPRIATE FLOWAGE EASEMENT AND TO FIX COMPENSATION *INSTANTER*

Pursuant to Rule 15 of the Ohio Rules of Civil Procedure and R.C. 163.12(C), Plaintiff State of Ohio, Department of Natural Resources ("ODNR") moves this Court for Leave to file a *Second Amended Petition to Appropriate Flowage Easement and to Fix Compensation* ("*Second Amended Petition*"). By filing the *Second Amended Petition*, ODNR seeks to incorporate a clear and accurate description and value of the property to be taken, which appropriately accounts for the scientific effects of the redesigned spillway, based on a 10-year flood event and, as an alternative claim, on the 2003 flood line. The grounds for this *Motion* are set forth in the attached *Memorandum in Support*. ODNR has also attached the proposed *Second Amended Petition* for this Court's convenience as Exhibit A.

Respectfully submitted,

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MEMORANDUM IN SUPPORT

I. FACTUAL BACKGROUND

In *State ex rel. Doner v. Zody*, 130 Ohio St.3d 446, 2011-Ohio 6117 ("*Doner*"), the Ohio Supreme Court determined that ODNR caused increased flooding on at least some of the Defendants' property. *Id.* at ¶ 83. Additionally, the Ohio Supreme Court held that the re-designed spillway caused "more frequent flooding, over a larger area, [and] longer in duration." However, the Ohio Supreme Court **did not** resolve the extent of the increases caused by the spillway modification. That is, the Ohio Supreme Court **did not** determine:

(A) **Flooding Frequency** - How much more frequent the Defendants' property is flooding?

(B) **Geographic Scope of Flooding** - How much larger of an area floods on the Defendants' property?

(C) **Flooding Duration** - How much longer the flooding lingers on the Defendants' property?

The Ohio Supreme Court mandated that "the determination of the extent of the taking will be made by the court presiding over the appropriation proceeding." *Id.* at ¶86. Obviously, then, this Court must make that determination.

II. PROCEDURAL BACKGROUND

To comply with the Ohio Supreme Court's mandamus order in *Doner*, the original *Petition to Appropriate Flowage Easement and to Fix Compensation* (the "*Petition*") for Defendants' property was filed on April 2, 2013. On April 18, 2013, ODNR filed an *Amended Petition to Appropriate Flowage Easement and to Fix Compensation* (the "*Amended Petition*") for the purpose of taking buildings, structures, or other improvements upon the property identified as permanent parcel 26-0428.0000 not otherwise included in the original *Petition*. As this Court is aware, the above-captioned case is now set for a jury trial May 21-23, 2014 to determine the value of the flowage easement. Recently, however, ODNR retained new special counsel who filed their notices of appearance on May 14, 2013.

Within the past 11 months, undersigned counsel has taken the lead on handling litigation related to all of the *Doner*-related cases. ODNR's new counsel has discovered some fundamental flaws in all of the petitions filed in response to the Ohio Supreme Court's decision in *Doner*. In order to correct those errors, ODNR's counsel has conducted voluminous research and hired new experts. These experts consist of George McMahon, Ph.D., PE, D.WRE ("Dr. McMahon"), a hydrologist, and Lance Brown, MAI ("Mr. Brown"), a real estate appraiser. For purposes of this *Motion*, the Court's attention is respectfully directed to three errors contained in the original *Petition* and first *Amended Petition*:

ERROR 1: <u>The 2003 flood line was not the correct measure for a flowage easement.</u>

Nearly everyone in the community readily acknowledges that the 2003 flood was an extraordinary event. It is well settled that an extraordinary flood event does not require the State of Ohio to take a flowage easement. *See e.g., Baird v. United States*, 5 Cl. Ct. 324, 329 (1984). Under Ohio law, a flowage easement is required to be taken for events that are intermittent, but inevitably recurring, with sufficient frequency to constitute an interference with the property. *Doner*, ¶ 80. Moreover, Ohio courts have held that an event that will occur less frequently than once every 10 years is not of sufficient frequency to constitute a taking. *Accurate Die Casting Co. v. City of Cleveland*, 2 Ohio App. 3d 386, 391, 442 N.E.2d 459 (8th Dist. 1981). Accordingly, our hydrological expert – Dr. McMahon – has prepared a hydrology report for Defendants' property using the 10-year event, which is both generous to the property owner and consistent with Ohio's legal standard.

ERROR 2: <u>The increase in flooding was not determined or quantified.</u>

In *Doner*, the Supreme Court found that, after the State of Ohio replaced the old spillway with the new one in 1997, flooding increased over at least some of the Relators' property in area, frequency, and duration. However, the original *Petition* and first *Amended Petition* did not determine or quantify those increases. Instead, the original *Petition* and first *Amended Petition* were based, not upon a hydrological study that was then reduced to an exhibit describing the extent of the take pursuant to R.C. 163.05 (as would be standard practice), but upon a metes and bounds description prepared by surveyors based solely on the estimated height of the 2003 flood marked by the Mercer County Engineer on bridge crossings. That description was flawed for at least three reasons.

First, the description was legally incorrect -- the 2003 flood line was not the appropriate measure (see above). Second, the description did not determine the extent of the take; the survey was not based upon a hydrological study that quantified any increase in flooding. And third, the description was wholly unnecessary -- flowage easements, in general, do not require metes and bounds descriptions, and R.C. 163.05 does not require a metes and bounds description for any type of taking - as Ohio courts have consistently determined. *Madison County Bd. of Comm'rs v. Bell*, 2007 Ohio 1373, ¶¶ 87-92 (12th Dist. 2007). Also, no information regarding the history of the area prior to 1997 was sought to verify or contradict the numerous property owners' claims that their property had flooded little and rarely before 1997, but flooded frequently and severely after 1997.

These deficiencies are also corrected by the *Second Amended Petition.* Our hydrological expert has generated two reports -- one based on a 10-year flood event and, as an alternative, the second based on the 2003 flood event. (See Affidavit of George McMahon, attached hereto as Exhibit B) Each report specifically determines and quantifies the increase in flooding in terms of area, frequency, and duration, and a significant amount of historic information has been gathered to document how frequent and severe the flooding along Beaver Creek and the Wabash River was prior to 1997 - giving real world support for ODNR's hydrologist's scientific conclusions.

ERROR 3: <u>The resulting appraised value was inaccurate.</u>

The Ohio Supreme Court ordered ODNR to take an easement over at least ***some*** of the *Doner* Relators' property for the increase in flooding it caused after the spillway was replaced in 1997. However, as a result of the first two errors, past appraisers retained by ODNR were never provided with a precise, properly determined, and quantified "extent of the take" to appraise. Instead, they were given an incorrect measure of the take (i.e. the 2003 flood high water mark), with no determination whatsoever of any actual increase in flooding, let alone a quantified measure upon which they could rely. In addition, past appraisers were provided with an inaccurate description of the nature of the take. The appraisers were told that the State of Ohio was acquiring the right to frequently, severely, and persistently flood anytime it wanted to, and for any reason. In contrast, *Doner* held that the State needed to acquire the right that it had already been exercising - the right to intermittently, but recurrently, increase flooding during sufficient levels of precipitation as a natural result of the reconstruction of the spillway in 1997.

This time, our appraiser – Mr. Brown – was provided with a correct measure for the flowage easement and a clear determination from a hydrological expert that specifically quantifies the extent of the take (be it based on the 10-year flood event or alternative 2003 flood event). Mr. Brown has also been provided an exhibit prepared by ODNR's surveyors that clearly describes the interests to be taken as determined and quantified by our hydrological expert (on both a 10-year flood event basis and alternative 2003 flood event basis), a significant amount of historic information related to the flooding of the subject property prior to 1997, and the accurate description of the nature of the take as determined by the Ohio Supreme Court in *Doner*. As a result, Mr. Brown has been able to more accurately value the property interest being taken, based on a 10-year flood event and, as an alternative, based on the 2003 flood event.

At this time, Defendants would not be unfairly prejudiced as a consequence of allowing ODNR to file the attached *Second Amended Petition*. To date, the Parties have conducted only limited discovery and no depositions have yet been scheduled.

In order to correct the errors in the State's original *Petition* and first *Amended Petition* without unfair prejudice to Defendants, ODNR hereby respectfully requests permission to file its *Second Amended Petition Instanter* to clearly and accurately define both the extent of the take and the value of the flowage easement on both the 10-year flood event basis and, alternatively, on the 2003 flood line basis.

III. LAW AND ARGUMENT

A. R.C. 163.12(C) specifically provides for the amendment of this petition.

With respect to appropriation petitions, R.C. 163.12(C) states that "[t]he court may amend any defect or informality in proceedings under sections 163.01 to 163.22 of the Revised Code." R.C. 163.05 (which governs the requirement of an appropriation petition) falls within those specified sections. Accordingly, it is clear that the General Assembly provided express authority for the amendment of an appropriation petition.

Indeed, Ohio courts have routinely allowed for similar amendments to petitions to appropriate. *See, e.g., Dorsey v. Donohoo*, 83 Ohio App.3d 415, 421–23, 615 N.E.2d 239 (12th Dist. 1992) (finding no error in allowing the board of county commissioners to amend its appropriation petition to add an easement for ingress and egress on the landowner's property);

see also *Madison Cty. Bd. of Commrs. v. Bell,* 12th Dist. No. CA2005-09-036, 2007-Ohio-1373, ¶¶4, 7 (Mar. 26, 2007) (holding that Board of Commissioners could amend its complaint seeking to appropriate under R.C. 163 to abandon part of the interest it was seeking to appropriate). In *Madison Cty. Bd. of Commrs.*, the Twelfth District Court of Appeals upheld the trial court's decision to allow the appropriating agency to amend their original petition. *Id.* The original petition requested a fee simple interest in the property; the Court allowed the appropriating agency to amend to request only an easement. *Id.* Here, ODNR seeks to amend its petition based upon new scientific data related to the extent of the take and the value of the permanent flowage easement.

B. Leave to file an amended pleading pursuant to Ohio Civil Rule 15 should be freely granted.

R.C. 163.12(C) permits parties to amend a petition for appropriation in accordance with Ohio Civ.R. 15. See *Wray v. Tattersall,* 6th Dist. No. L–98–1030, 1998 WL 636797 *5 (Sept. 18, 1998). According to the Ohio Supreme Court, "when a tribunal is faced with a request for leave to amend a complaint, Civ.R. 15(A) directs it to grant such leave '**freely**' and '**when justice so requires**.'" *Columbus Bar Ass'n v. Dougherty,* 99 Ohio St. 3d 147, 2003-Ohio-2672, 789 N.E.2d 621 at ¶15 (Emphasis added). It is a well-established principle in Ohio that "[t]he language of Civ.R. 15(A) favors a liberal policy when the trial judge is confronted with a motion to amend a pleading." *Wray,* 6th Dist. No. L-98-1030; citing *Wilmington Steel Products, Inc. v. Cleveland Elec. Illum. Co,* 60 Ohio St.3d 120, 122, 573 N.E.2d 622 (1991).

Here, justice would be served by allowing the *Second Amended Petition* to be filed, which provides an updated and accurate description of the flowage easement ODNR was ordered to acquire, based on both a 10-year flood event and, as an alternative claim, the 2003 flood event. Specifically, the *Second Amended Petition* is based on Dr. McMahon's two alternative hydrological reports, which scientifically describe for all parties the extent of the take on a 10-year flood event basus and, as an alternative, on the 2003 flood event basis. Accordingly, this amendment corrects the defects in the original *Petition* and first *Amended Petition* that justice requires. The Defendants are entitled to fair and adequate compensation under the law, just as the other taxpayers of Ohio are entitled to a just and fair process where they are not forced to take or pay more than what is required under the law simply because of past errors and oversights that can, and should, be corrected now.

C. Allowing Plaintiff to amend its petition presents no undue delay, bad faith or dilatory motive, poses no unfair prejudice to Defendants, and will promote judicial economy.

Defendants will not be prejudiced by the filing of the *Second Amended Petition.* ODNR's claims remain the same – the procedure set forth in the *Doner* mandamus order has not changed, the *Second Amended Petition* simply corrects the legal, scientific and historic defects in the original *Petition* and first *Amended Petition.* Furthermore, the Parties have thus far engaged in only limited written discovery and have not scheduled depositions.

Also, as the Court is aware, the Defendants are not required to accept the State's determination of the extent of the take on their property. They may contest that issue as a preliminary matter before the valuation phase of the appropriation proceedings. Pursuant to the *Doner* decision, this Court should determine the extent of the take, while the compensation for the take should be decided by the Jury. Therefore, if the Defendants contest the extent of the take described in the *Second Amended Petition*, an Evidentiary Hearing should be held before the Court. The Court should determine the extent of the take, and either party may appeal that determination.

IV. CONCLUSION

In light of the foregoing and in the interest of complying with the Ohio Supreme Court's Order in *Doner*, ODNR respectfully requests that this Court grant it leave to file the attached *Second Amended Petition* in the above-captioned case.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a true and accurate copy of the foregoing was served by U.S. Mail, pursuant to Ohio Civ.R. 5(B)(2)(c), this 25th day of April, 2014, on the following:

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FBT Law Documents 0126934.0606206 4826-5190-7354v1

IN THE COURT OF COMMON PLEAS
MERCER COUNTY, OHIO

STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES 2045 Morse Road, Building D-3 Columbus, Ohio 43229, Plaintiff, v. THE JOHN H. ZUMBERGE TRUST UAD 1990, CHARLES F. AND JENNIFER M. ZUM BERGE, TRUSTEES 6612 Meyer Road Celina, Ohio 45822 and VIRGINIA L. ZUMBERGE TRUST UAD JANUARY 31, 1990, CHARLES F. AND JENNIFER ZUMBERGE, TRUSTEES 6612 Meyer Road Celina, Ohio 45822 and RANDY GRAPNER Mercer County Auditor 101 North Main Street, Room 105 Celina, Ohio 45822, and DAVID KAISER Mercer County Treasurer 101 North Main Street, Room 201 Celina, Ohio 45822, Defendants.	Case No. 13-CIV-083 Judge Jeffrey R. Ingraham SECOND AMENDED PETITION TO APPROPRIATE FLOWAGE EASEMENT AND TO FIX COMPENSATION

EXHIBIT
A

Pursuant to the Ohio Supreme Court's Judgment Entry dated December 1, 2011, Plaintiff State of Ohio, Department of Natural Resources ("ODNR") brings this *Second Amended Petition* to appropriate a flowage easement, and alleges as follows:

1. ODNR is a public agency as defined in R.C. 163.01.

2. This *Petition* is brought by ODNR pursuant to its authority under R.C. 1501.01, R.C. 163.01, *et seq.*, and in full compliance with *Doner*.

3. Defendants are those persons or entities, based upon preliminary review of title or otherwise, who may possess legal interest(s) in property located in Mercer County, Ohio (as more particularly described as Mercer County Auditor's Parcel Nos. 26-022600.0000, 26-051000.0000, and 26-052900.0000) over a portion of which the herein flowage easement is being acquired.

4. Defendants' loss of property is not a permanent, complete conversion of private property for public use, which would require an appropriation of a fee simple interest in Defendants' property.

5. Instead, any increase in flooding on Defendants' property that does occur creates only a temporary loss of Defendants' use of the property, which would justify an appropriation of a flowage easement interest in their property.

6. To date, ODNR has been unable to agree with Defendants on the terms for conveyance of a flowage easement.

7. In advance of filing this *Petition*, ODNR has complied with the requirements of R.C. 163.04.

8. The purpose of this *Petition* is to acquire a flowage easement, free and clear of all liens, claims and encumbrances, and to fix compensation, in full compliance with the Ohio Supreme Court's December 1, 2011 *Judgment Entry* in *Doner*.

COUNT I

(10-Year Flood Event)

9. This Court recently determined in the related cases of *ODNR v. Nelda G. Thomas, et al.*, Mercer C.P. No. 12-CIV-208, *ODNR v. Jerry W. Powell, et al.*, Mercer C.P. No. 12-CIV-206, and *ODNR v. Timothy Knapke, et al.*, Mercer C.P. No. 12-CIV-209 that the post-appropriation extent of the take for valuation purposes is the 2003 flood line. *See Thomas, Judgment Entry on Motion for Leave to File Amended Complaint* (Jan. 17, 2014); *Powell, Judgment Entry on Motion for Leave to File Amended Complaint* (Feb. 12, 2014); *Knapke, Judgment Entry on Motion for Leave to File Amended Complaint* (Mar. 7, 2014).

10. ODNR respectfully disagrees with this Court's determination and asserts that the appropriate determination of the post-appropriation extent of the take for valuation purposes is the measure of a 10-year flood event.

11. In order to preserve this issue for appeal while allowing the case to proceed to trial as expeditiously as possible, ODNR proffers the 10-year flood event-based flowage easement to be appropriated in this case as that described in Exhibit 1, attached hereto and fully incorporated by reference.

COUNT II

(2003 Flood Line)

12. Alternative to the above, in the event this Court dismisses Count I or otherwise determines in this case as it did in *Thomas*, *Powell*, and *Knapke* that the post-appropriation extent of the take for valuation purposes is the 2003 flood line, the legal description of the 2003 flood line-based flowage easement to be appropriated in this case is that described in Exhibit 2, attached hereto and fully incorporated by reference.

WHEREFORE, ODNR prays the Court will:

A. Enter a judgment on Count I or, in the alternative Count II, ordering the conveyance of a perpetual flowage easement in the subject property to ODNR;

B. Cause a jury to be impaneled to make inquiry into and assess compensation to be paid for the appropriation of the permanent flowage easement; and

C. Grant ODNR all such other relief to which it may be entitled.

Respectfully submitted,

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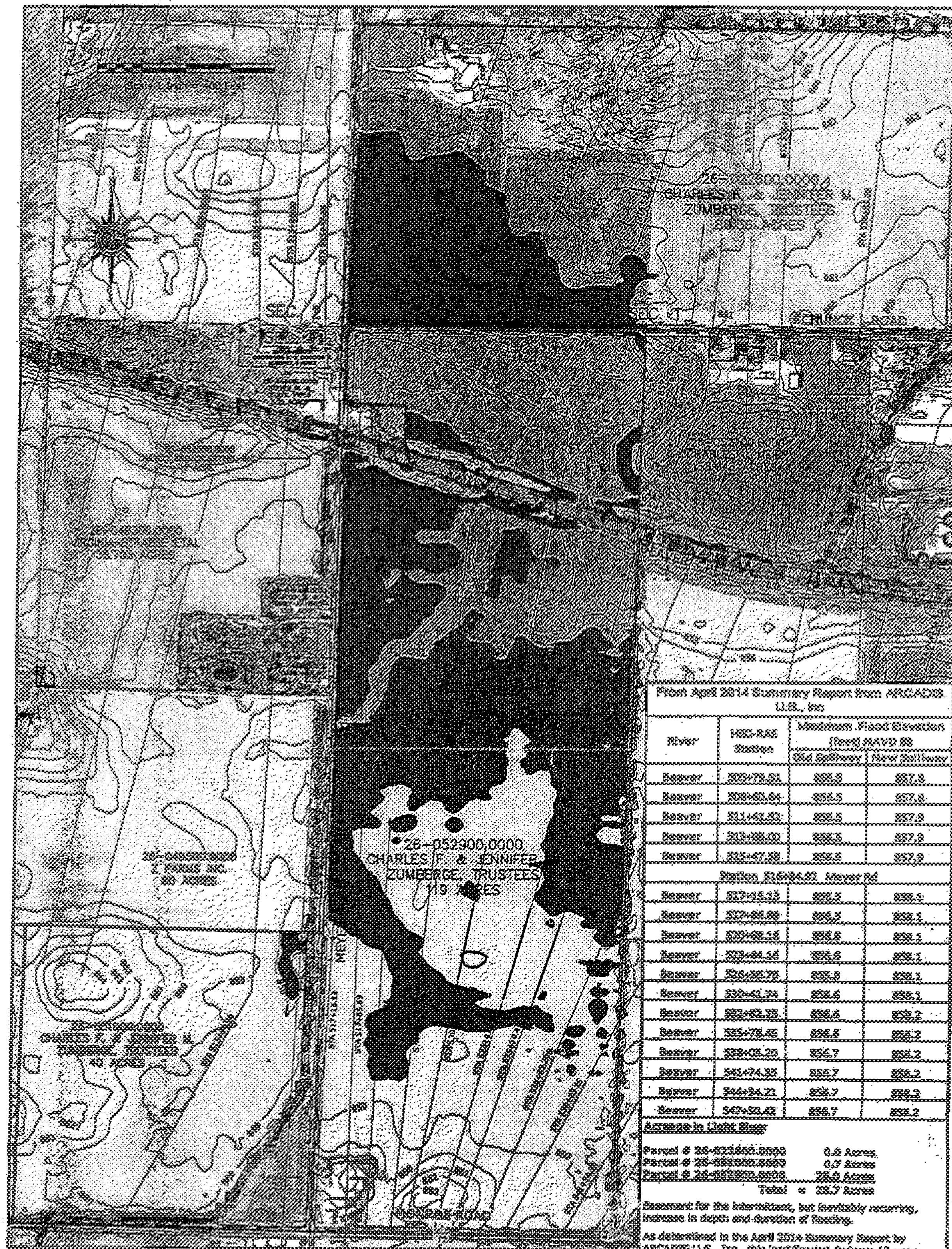
FBT Law Documents 0126934.0606206 4845-7453-6474v1



From April 2014 Summary Report from ARCADIS U.S., Inc			
River	HEC-RAS Station	Maximum Flood Elevation (feet) NAVD 88	
		Old Spillway	New Spillway
Beaver	305+78.51	856.5	857.9
Beaver	308+63.64	856.5	857.9
Beaver	311+41.43	856.5	857.9
Beaver	313+88.00	856.5	857.9
Beaver	315+67.58	856.5	857.9
Station 316+84.92 Meyer Rd			
Beaver	317+15.13	856.5	858.1
Beaver	317+81.88	856.5	858.1
Beaver	320+68.16	856.6	858.1
Beaver	323+84.16	856.6	858.1
Beaver	326+36.78	856.8	858.1
Beaver	330+61.74	856.6	858.1
Beaver	332+82.35	856.6	858.2
Beaver	335+78.45	856.6	858.2
Beaver	338+08.20	856.7	858.2
Beaver	341+74.35	856.7	858.2
Beaver	344+34.21	856.7	858.2
Beaver	347+52.42	856.7	858.2

Acreage in Light Blue:

Parcel # 26-022600.0000	0.0 Acres
Parcel # 26-051000.0000	0.7 Acres
Parcel # 26-052900.0000	28.0 Acres
Total =	28.7 Acres

Easement for the intermittent, but inevitably recurring, increase in depth and duration of flooding.

As determined in the April 2014 Summary Report by ARCADIS U.S., Inc., this land flooded during a 10-year flood when the pre-1997 spillway was in place, but floods for a longer duration (approximately 2.28 days longer on parcel 26-022600.0000, approximately 2.17 days longer on parcel 26-051000.0000), and for a shorter duration (approximately 10.55 days longer on parcel 26-052900.0000) and to an increased maximum depth (1.5 feet deeper on average) during a 10-year flood with the post-1997 spillway in place.

This exhibit is a description of the use which requires the appropriation pursuant to Section 163.05(C) of the Ohio Revised Code.

Note: Cross Sections and Stations shown hereon are from the April 2014 Summary Report by ARCADIS U.S., Inc.

Acreage in Dark Blue:

Parcel # 26-022600.0000	15.8 Acres
Parcel # 26-051000.0000	0.8 Acres
Parcel # 26-052900.0000	42.7 Acres
Total =	59.3 Acres

Flowage Easement for the intermittent, but inevitably recurring, increase in area flooded.

As determined in the April 2014 Summary Report by ARCADIS U.S., Inc., this land did not flood during a 10-year flood when the pre-1997 spillway was in place, but does flood during a 10-year flood with the post-1997 spillway in place.

STATE OF OHIO
ROBERT L. SNELLER
S-6738
REGISTERED
PROFESSIONAL SURVEYOR

BY: Robert L. Sneller 6/23/14

Robert L. Sneller, P.S. Date
Professional Surveyor No. 6738

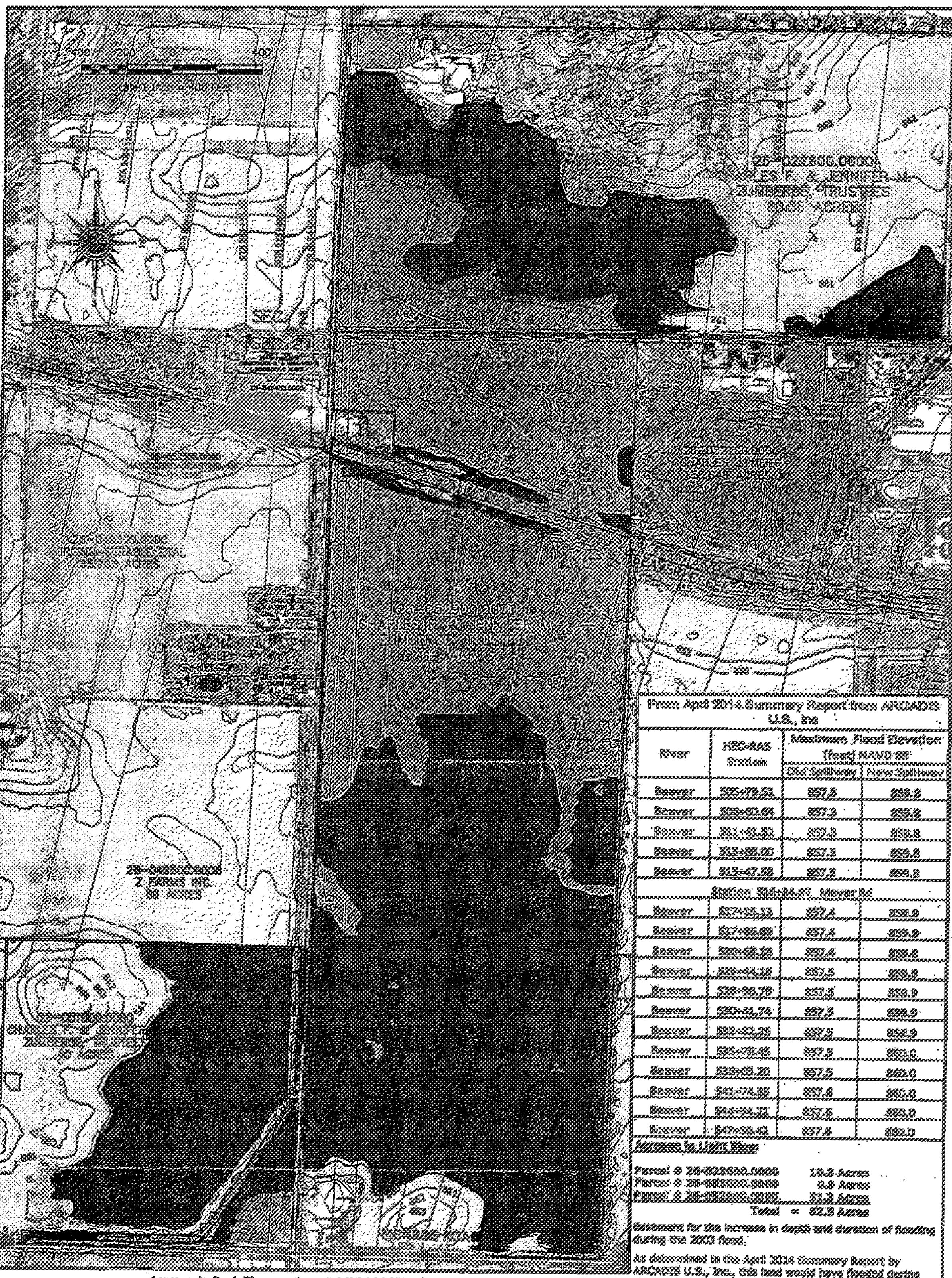
EXHIBIT

1

Office of Real Estate
Ohio Department of Natural Resources
2045 Morse Road, Bldg. E-2
Columbus, OH 43229

Parts of Sections 1, 11, 12,
Twp 6 South, Range 2 E
Jefferson Township
Mercer County, Ohio

C. F. & J. M. ZUMBERGE,
TRUSTEES
Flowage Easement Exhibit



From April 2014 Summary Report from ARCADIS U.S., Inc

River	HEC-RAS Station	Maximum Flood Elevation (feet) NAVD 88	
		Old Spillway	New Spillway
Beaver	305+78.51	857.3	859.8
Beaver	308+60.64	857.3	859.8
Beaver	311+41.52	857.3	859.8
Beaver	313+88.00	857.3	859.8
Beaver	315+47.58	857.3	859.8
Station 316+34.82 Meyer Rd			
Beaver	317+55.13	857.4	859.9
Beaver	317+86.69	857.4	859.9
Beaver	320+48.38	857.4	859.8
Beaver	323+44.16	857.5	859.8
Beaver	326+36.78	857.5	859.9
Beaver	330+41.74	857.5	859.9
Beaver	332+82.26	857.5	859.9
Beaver	335+78.45	857.5	860.0
Beaver	338+03.20	857.5	860.0
Beaver	341+74.35	857.6	860.0
Beaver	344+34.72	857.6	860.0
Beaver	347+53.41	857.6	860.0

Acreage In Light Blue

Parcel # 26-022600.0000 19.2 Acres
Parcel # 26-051000.0000 0.8 Acres
Parcel # 26-052600.0000 [illegible] Acres
Total = 82.3 Acres

Easement for the increase in depth and duration of flooding during the 2003 flood.

As determined in the April 2014 Summary Report by ARCADIS U.S., Inc., this land would have flooded during the 2003 flood even if the old (pre-1997) spillway was in place, but it flooded for a shorter duration (approximately 3.89 days shorter on parcel 26-022600.0000, approximately 4.42 days shorter on parcel 26-051000.0000, and approximately 18.38 days shorter on parcel 26-052600.0000) and to an increased maximum depth (2.5 feet deeper on average) during the 2003 flood with the post-1997 spillway in place.

This exhibit is a description of the use which requires the appropriation pursuant to Section 163.05(C) of the Ohio Revised Code.

Note: Cross Sections and Stations shown hereon are from the April 2014 Summary Report by ARCADIS U.S., Inc.

Acreage In Dark Blue

Parcel # 26-022600.0000 23.3 Acres
Parcel # 26-051000.0000 21.6 Acres
Parcel # 26-052600.0000 41.3 Acres
Total = 106.2 Acres

Flowage Easement for the intermittent, but inevitably recurring, increase in area flooded.

As determined in the April 2014 Summary Report by ARCADIS U.S., Inc., this land would not have flooded during the 2003 flood if the old (pre-1997) spillway had been in place, but did flood during the 2003 flood with the new (post-1997) spillway in place.

STATE OF OHIO
ROBERT L. SNELLER
S-6738
REGISTERED
PROFESSIONAL SURVEYOR

BY: Robert L. Sneller 4/23/14

Robert L. Sneller, P.S. Date
Professional Surveyor No. 6738

EXHIBIT
2

Office of Real Estate
Ohio Department of Natural Resources
[illegible]
Columbus, OH [illegible]

Parts of Sections 1, 11, 12,
Twp 6 South, Range 2 E
Jefferson Township
Mercer County, Ohio

C. F. & J. M. ZUMBERGE,
TRUSTEES
Flowage Easement Exhibit

IN THE COURT OF COMMON PLEAS
MERCER COUNTY, OHIO

STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES, **Plaintiff,** **v.** **THE JOHN H. ZUMBERGE TRUST UAD 1990, et al., *et al.*,** **Defendants.**	:	**Case No.: 13-CIV-083** **Judge Jeffrey R. Ingraham** **AFFIDAVIT OF GEORGE F. MCMAHON**

I, George F. McMahon, being first duly cautioned, swear or affirm as follows:

1. I am employed as a Vice President of ARCADIS-US, Inc.

2. I have personal knowledge of the facts contained in this Affidavit.

3. I am a hydrologist retained for purposes of evaluating the flood impact of spillway improvements.

4. On behalf of ARCADIS-US, Inc., I developed hydrologic and hydraulic models for determination of the exact acreage to appropriate a permanent flowage easement due to spillway modification for the property located on Defendants' property, i.e., Mercer County, Ohio Recorder's Office Parcel Nos. 26-022600.0000, 26-051000.0000, and 26-052900.0000.

5. Based upon these model results, attached as Exhibit 1 is a report I authored demonstrating the exact appropriation due to the spillway improvements on the Property based upon a 10-year flood event.

6. Further based upon these same model results, attached as Exhibit 2 is a report I authored demonstrating the exact appropriation due to the spillway improvements on the Property based upon the 2003 flood event.

George F. McMahon, Ph.D., PE, D.WRE

Sworn to or affirmed before me and subscribed in my presence this 23 day of ~~March,~~ April

2014, in the state of Georgia and the county of Fulton.

Notary Public

FBT Law-Documents 0126934.0606206 4833-9193-9866v1

Notary Public, Fulton County, Geor
My Commission Expires Sept. 11,

EXHIBIT

B

Ohio Department of Natural Resources

Flood Impacts of Spillway Improvements
10-year flood

Charles and Jennifer Zumberge Parcels
Parcel Numbers 26-022600.0000, 26-051000.0000 and 26-052900.0000

Grand Lake Saint Marys,
Beaver Creek and Wabash River

April 2014

ARCADIS
Infrastructure · Water · Environment · Buildings

EXHIBIT
1

1. Purpose and scope

This report summarizes impacts on flooding of the Jerry and Betty Zumberge parcels due to improvements to the Grand Lake St. Mary's (GLSM) Dam spillway. The spillway crest length was increased in 1997 to bring the dam into compliance with Ohio Dam Safety Laws and Regulations (ORC Title XV as amended).

Expected impacts of spillway improvements on flooding were determined by hydrologic and hydraulic simulation of basin response to the 10-year flood, resulting from application of the NOAA 96-hour 10-year rainfall to the Beaver Creek – Wabash River basin.[1] The 10-year flood has a 10% chance of exceedence in any year, or alternatively is equaled or exceeded on average once in 10 years. Because GLSM spillway operation following spillway modification in 1997 has been uncontrolled (free overflow), reservoir outflow is always less than the peak rate of inflow, illustrated in the case of the 10-year flood in Figure 1. Consequently, no matter the temporal and spatial distribution of rainfall within the GLSM watershed, peak flood level on any specific parcel downstream of GLSM will always be lower with the new spillway in operation than would occur naturally, i.e. if GLSM did not exist.

Rainfall-runoff modeling was performed using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), version 3.5. HEC-HMS is a generalized computer program that simulates precipitation-runoff processes of dendritic river basins and reservoir systems.

Computed inflow to GLSM for the 10-year storms was routed through the GLSM reservoir and dam for the pre-1997 and post-1997 spillway, as follows:

- **Releases** over the pre-1997 spillway with two of the four gated low-level outlets opened 24 inches (out of a possible 32 inches) when GLSM reservoir level exceeds 871.1, one foot above spillway crest; operation consistent with standard

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[1] NOAA Atlas 14, National Weather Service Hydrometeorological Design Studies Center, Precipitation Frequency Data Server (PFDS) http://hdsc.nws.noaa.gov/hdsc/pfds/index.html

operating procedures and the maintenance condition of the gates prior to construction of the new spillway in 1997

- Free-overflow releases from the improved (post-1997) spillway

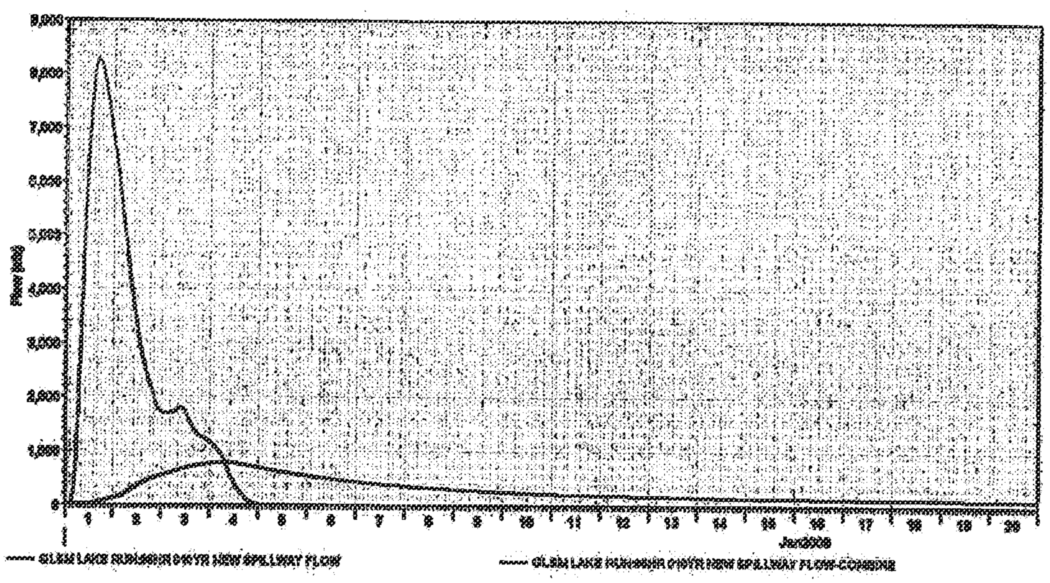

Figure 1: GLSM inflow (red) and new spillway outflow (blue), 10-year flood

Grand Lake St. Marys outflow time series generated by HEC-HMS were combined with subbasin runoff hydrographs, and routed (one-dimensional unsteady flow routing) through the main channel and principal tributaries of Beaver Creek and the Wabash River downstream of GLSM using the HEC-RAS (River Analysis System) model, version 4.1.0. The model domain extends from the GLSM spillway west to the Ohio-Indiana border, including reaches of Beaver Creek, Wabash River, Big Run, Little Beaver Creek, and an unnamed tributary. Figure 2 displays a study area map with modeled streams, approximate location of plaintiff's properties and the FEMA 100-year flood zone.

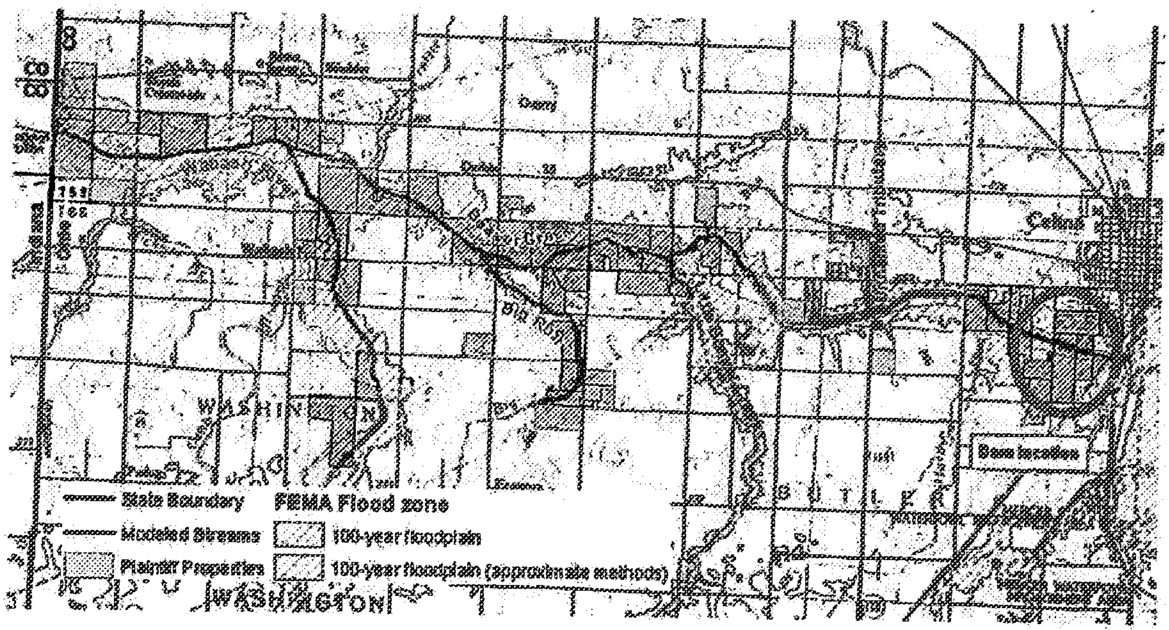

Figure 2: Beaver Creek and Wabash River study area map

The HEC-HMS model encompasses the entire watershed draining to the Wabash River above the Ohio-Indiana line; the model domain and major components are shown in Figure 3.

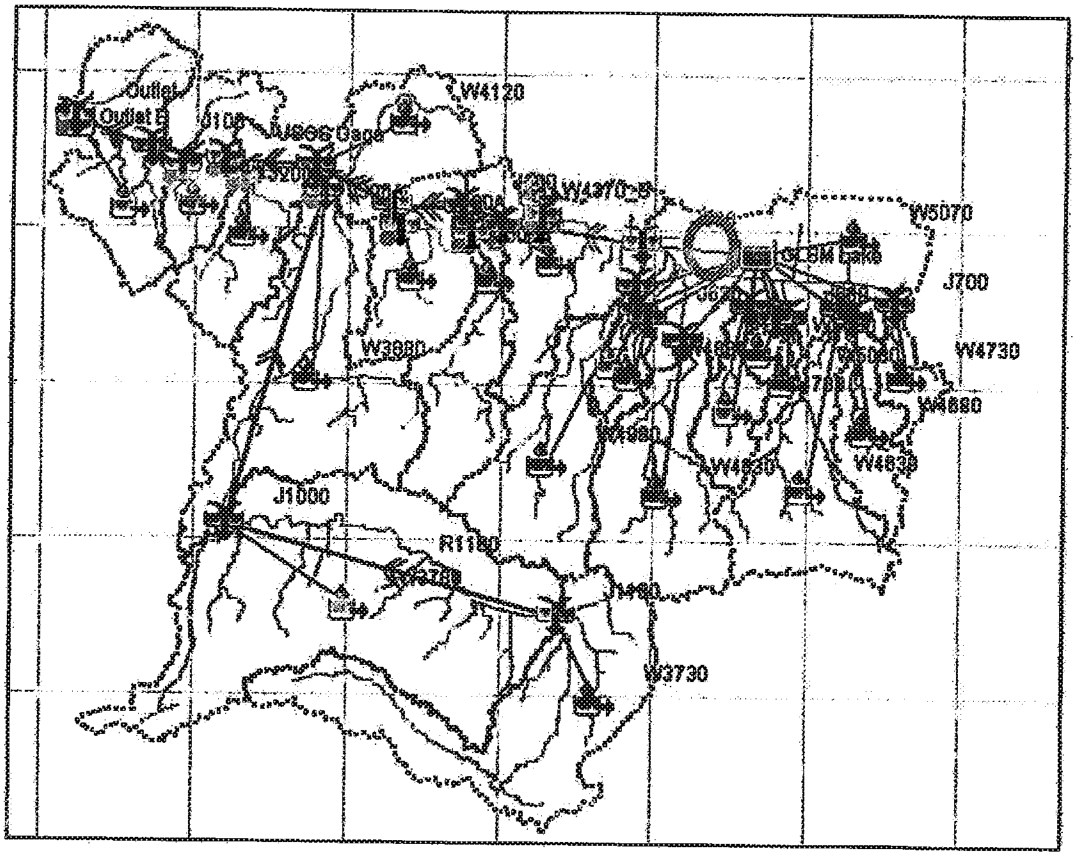

Figure 3: Wabash River Basin HEC-HMS model components

The extent of hydraulic (HEC-RAS) modeling is based on the location of plaintiffs' properties along the main stream receiving flow from the dam, Beaver Creek and Wabash River below Beaver Creek, and major tributaries. While several tributaries contribute flow to the main receiving channel, only tributaries with plaintiffs affected by tributary flooding were explicitly modeled using HEC-RAS cross sections. The HEC-RAS model, shown in overview in Figure 4 is high resolution with closely-spaced cross sections, a total of 15 of which traverse Zumberge parcels numbered 26-022600.0000 (northern), 26-052900.0000 (middle) and 26-051000.0000 (southern).

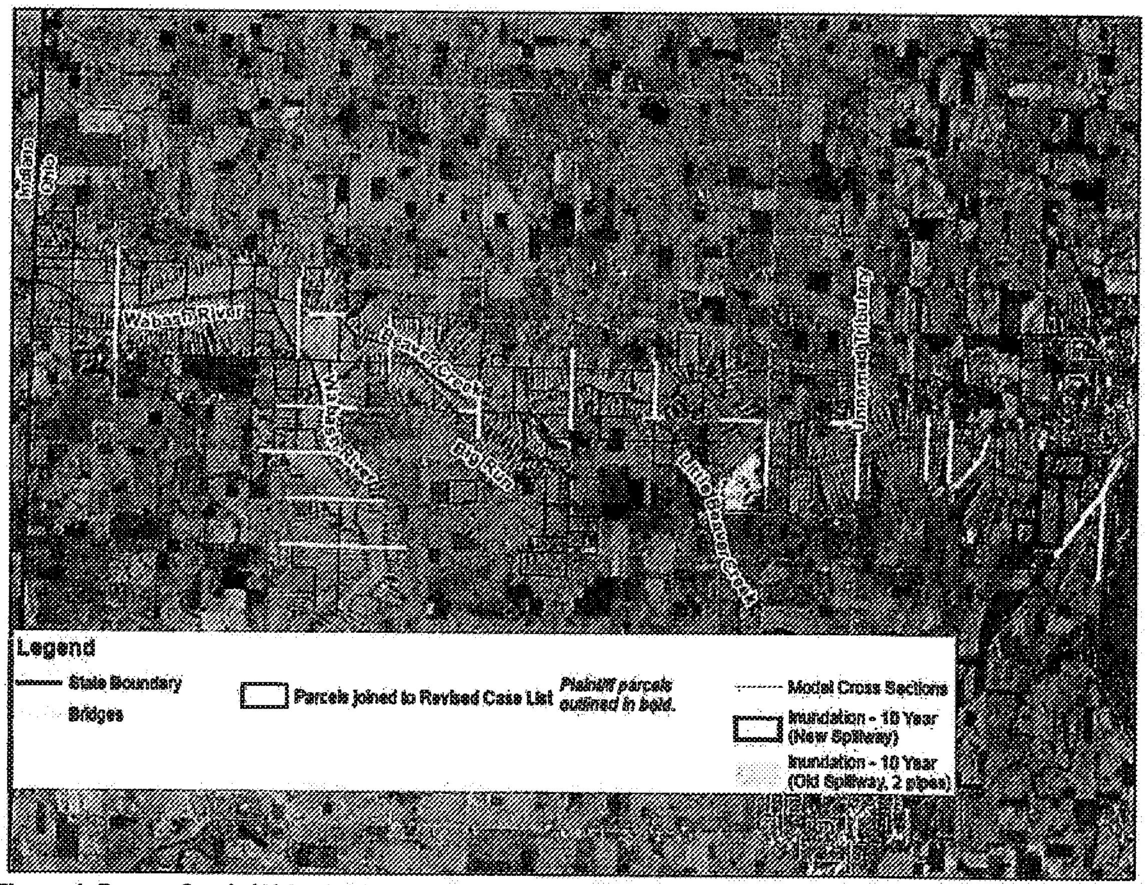

Figure 4: Beaver Creek, Wabash River and major tributary HEC-RAS model cross sections, showing location of Zumberge parcels

The downstream boundary of the hydraulic model is located just upstream of the Ohio-Indiana border. A rating curve was used as the downstream boundary, developed based on historic records for the USGS New Corydon Gage and extrapolated to extreme high-flow events. Extrapolation was performed by non-linear regression of HEC-RAS model-computed stages downstream of the bridge at State Line Road, over a range of steady (non time-varying) flows. The New Corydon Gage is located as shown in Figure 5.

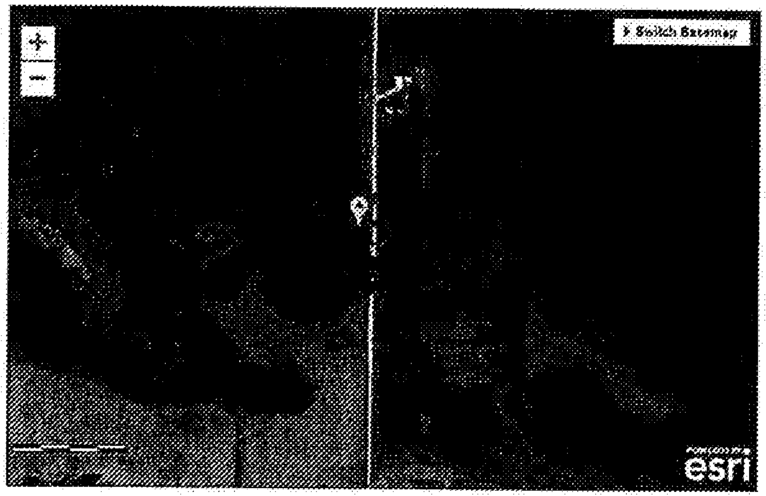

Figure 5: USGS New Corydon Gage (HEC-RAS model downstream boundary) location

2. Parcel location

The Zumberge parcels (26-022600.0000, 26-052900.0000 and 26-051000.0000) are located respectively on the north side, across and on the south side of Beaver Creek just downstream of the GLSM spillway – the upstream HEC-RAS model boundary. The parcels are shown in overview in Figure 4 and enlarged in Figure 10.

3. Analysis results – effects of GLSM spillway improvements

Hydrologic and hydraulic simulation results presented in this report enable comparisons of flood impacts of pre- and post-1997 GLSM spillway operation for the 10-year flood. The following information is provided:

- Flood propagation, i.e. change in magnitude and timing of flood flow moving downstream from the GLSM spillway and associated flood stage at the midpoint of each of the Zumberge parcels
- Flood statistics, i.e. peak flow, elevation, flooded area and duration
- Flood inundation mapping

Flood information is presented in graphical and tabular format in subsequent sections of this report.

3.1 Flood propagation

Figure 6 shows GLSM discharge and Beaver Creek flow and stage at the mid-point of the northern and middle Zumberge parcels (numbers 26-022600.0000 and 26-052800.0000) for the 10-year flood with old and new spillways. Both parcels are represented by HEC-RAS model cross section 52344. Cross-section number in this case indicates distance (in feet) moving upstream from the Beaver Creek confluence with the Wabash River, with GLSM dam located at the most upstream cross section, number 56214.

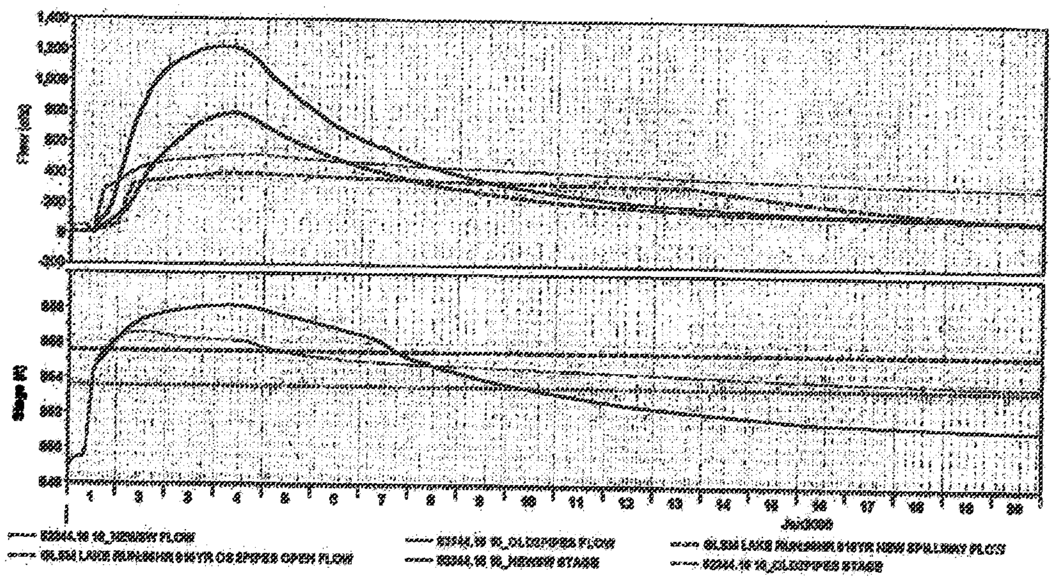

Figure 6: Simulated 10-year flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on Zumberge parcels 26-022600.0000 (northern) and 26-052900.0000 (middle), both represented by cross section 52344 (blue – new spillway, red – old spillway); black dashed line – northern parcel representative elevation (855.5); black dotted line – middle parcel representative elevation (853.5)

Figure 7 shows GLSM discharge and Beaver Creek flow and stage on the southern Zumberge parcel (26-051000.0000) for the 10-year flood with old and new spillways. The parcel is represented by HEC-RAS model cross section 51386. Cross-section number indicates distance (in feet) moving upstream from the Beaver Creek confluence with the Wabash River, with GLSM dam located at cross section 56214.

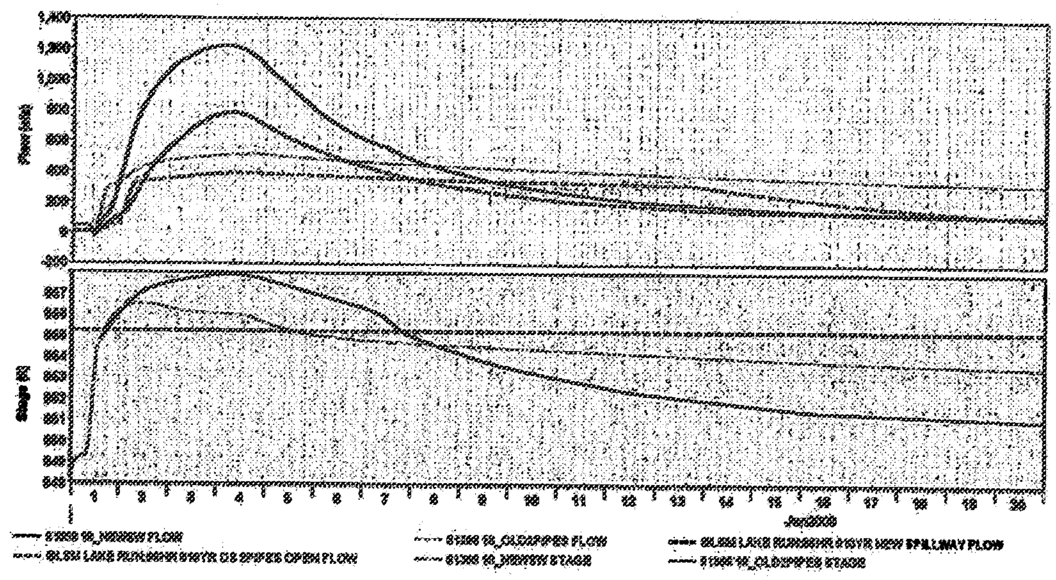

Figure 7: Simulated 10-year flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on the southern Zumberge parcel, number 28-051000.0000, represented by cross section 51386 (blue – new spillway, red – old spillway); black dashed line – parcel representative elevation (855.2)

Flood profiles, showing peak water surface elevations in the main Beaver Creek-Wabash River reach for the pre- and post-1997 spillway configurations, are plotted in Figure 8. The relative location of the Zumberge parcels, denoted by a red arrow, is on Beaver Creek less than a mile downstream of the GLSM spillway. Due to their proximity to the upstream model boundary, all three parcels experience greater depth of flooding with the new spillway, and the northern and middle parcels significantly more flooded area as well. Flooded area on the southern parcel, however, is limited because most of this property sits at a higher elevation than the other two, and flooding is mostly confined to a drainage ditch running along its eastern and southern boundaries. Summary HEC-RAS model results for sections crossing and in the vicinity of the Zumberge parcels are shown in Table 4 of the Appendix.

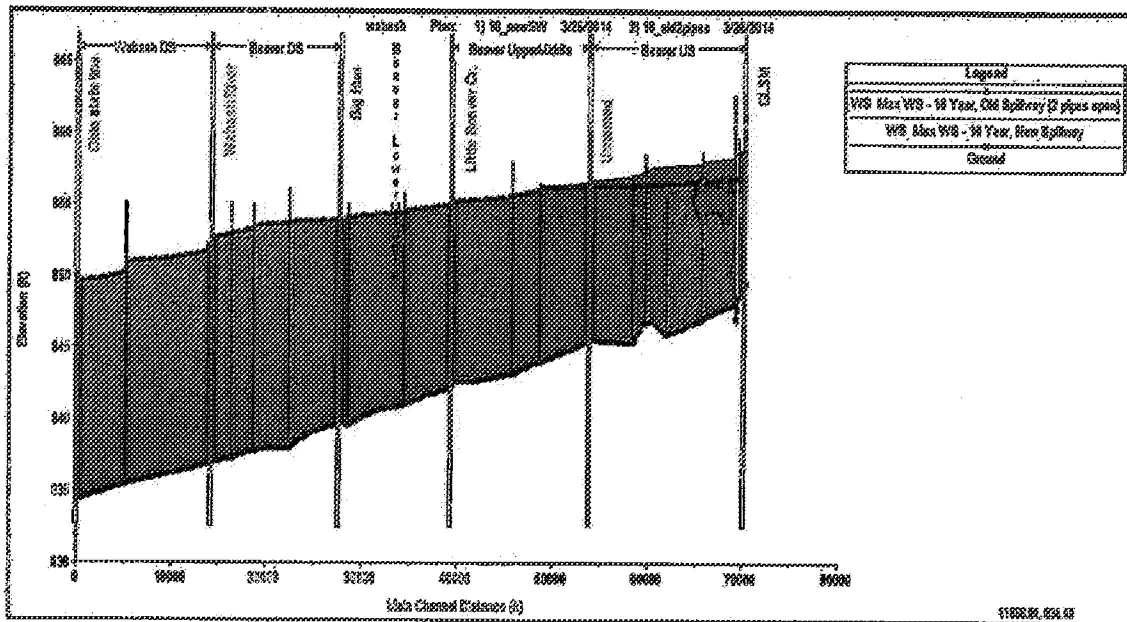

Figure 8: 10-year flood profiles, main Beaver Creek-Wabash River reach for pre- and post-1997 spillway configurations (red lines – tributary junctions; blue triangles – old spillway, solid blue line – new spillway, red arrow – Zumberge parcels)

3.2 Flood statistics

Selected statistics for the 10-year flood are presented in Table 1 for the northern Zumberge property (parcel 26-022600.0000), Table 2 for the southern parcel (26-051000.0000) and Table 3 for the middle parcel (26-052900.0000). Due to their location near the GLSM spillway, the post-1997 spillway improvements significantly increase peak flood level on all three parcels, and duration of flooding on the northern and southern parcels. However, flood duration is much less with the new spillway on the middle parcel because it is sufficiently low that it is subject to flooding during the more than 10 extra days needed to lower the reservoir using the old spillway. Because the southern parcel sits at a higher elevation, flooded area is mostly confined to a drainage ditch running along its eastern and southern borders. As shown in Figures 6 and 7, Beaver Creek peak flow past the parcels is largely determined by flow over the GLSM spillway.

Table 1: Selected flood statistics for Zumberge Parcel Number 26-022600.0000 (northern parcel)

	Flood event	HEC-RAS station	Peak flow (cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 853.6 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 26-022600.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 853.6 (Visually selected)	10-year	51716	514	1213	699	856.6	858.1	1.6	0.0	18.8	18.8	3.64	5.92	2.33
		51787	514	1213	699	856.6	858.1	1.6						
		52068	514	1214	700	856.6	858.1	1.6						
		52344	513	1215	702	856.6	858.1	1.5						
		52637	512	1216	704	856.6	858.1	1.5						
		53042	511	1217	706	856.6	858.1	1.6						
		53282	510	1218	708	856.6	858.2	1.6						
		53578	508	1218	710	856.6	858.2	1.6						
		53803	507	1219	712	856.7	858.2	1.6						

Table 2: Selected flood statistics for Zumberge Parcel Number 26-052900.0000 (middle parcel)

	Flood event	HEC-RAS station	Peak flow (cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 851.8 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 26-052900.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 851.8 (Levee low point)	10-year	51716	514	1213	699	856.6	858.1	1.6	28.0	70.7	42.7	19.51	8.87	-10.64
		51787	514	1213	699	856.6	858.1	1.6						
		52068	514	1214	700	856.6	858.1	1.6						
		52344	513	1215	702	856.6	858.1	1.5						
		52637	512	1216	704	856.6	858.1	1.6						
		53042	511	1217	706	856.6	858.1	1.5						
		53282	510	1218	708	856.6	858.2	1.6						
		53578	508	1218	710	856.6	858.2	1.6						
		53803	507	1219	712	856.7	858.2	1.5						
		54174	505	1221	716	856.7	858.3	1.6						
		54434	505	1222	717	856.7	858.3	1.6						

Table 3: Selected flood statistics for Zumberge Parcel Number 26-051000.0000 (southern parcel)

	Flood event	HEC-RAS station	Peak flow(cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 856.2 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 26-051000.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 856.2 (Visually selected)	10-year	60861 61142 61385 61648	616 615 614 614	1212 1213 1213 1213	596 598 599 599	856.6 856.6 856.5 856.5	857.8 857.9 857.9 857.9	1.2 1.3 1.4 1.4	0.7	1.5	0.8	3.92	6.09	2.17

3.3 Inundation map

Figure 9 shows inundated area for the 10-year flood on the Zumberge parcels for pre- and post 1997 spillway configurations.

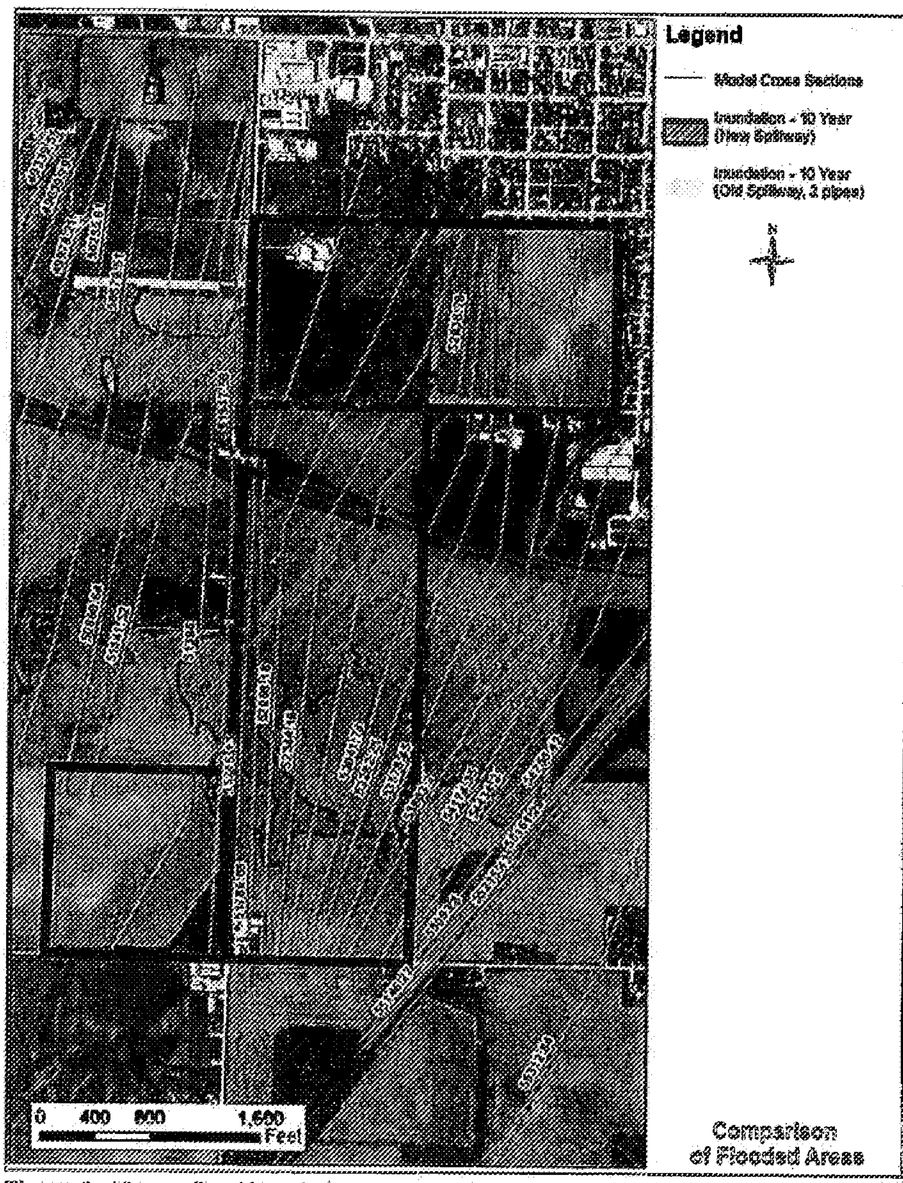

Figure 9: 10-year flood inundation map, Zumberge parcels, numbers 26-022600.0000 (northern), 26-052900.0000 (middle) and 26-051000.0000 (southern)

4. Conclusions

This study shows that the Zumberge parcels are significantly affected by the new spillway largely due to their location less than a mile downstream. All parcels experience about 1.5 feet of increased flood depth, and the northern and southern parcels about 2.5 days of additional flood duration. However, duration of flooding is greatly reduced (by about 10.5 days) in the middle parcel by the new spillway due to the parcel's low level, coupled with the additional time needed to lower the reservoir using the old spillway in comparison to the time required by the new spillway. The increase in flooded area of the southern parcel is less than an acre and mostly confined to a ditch running along its eastern and southern borders.

Appendix

Figures and Tables

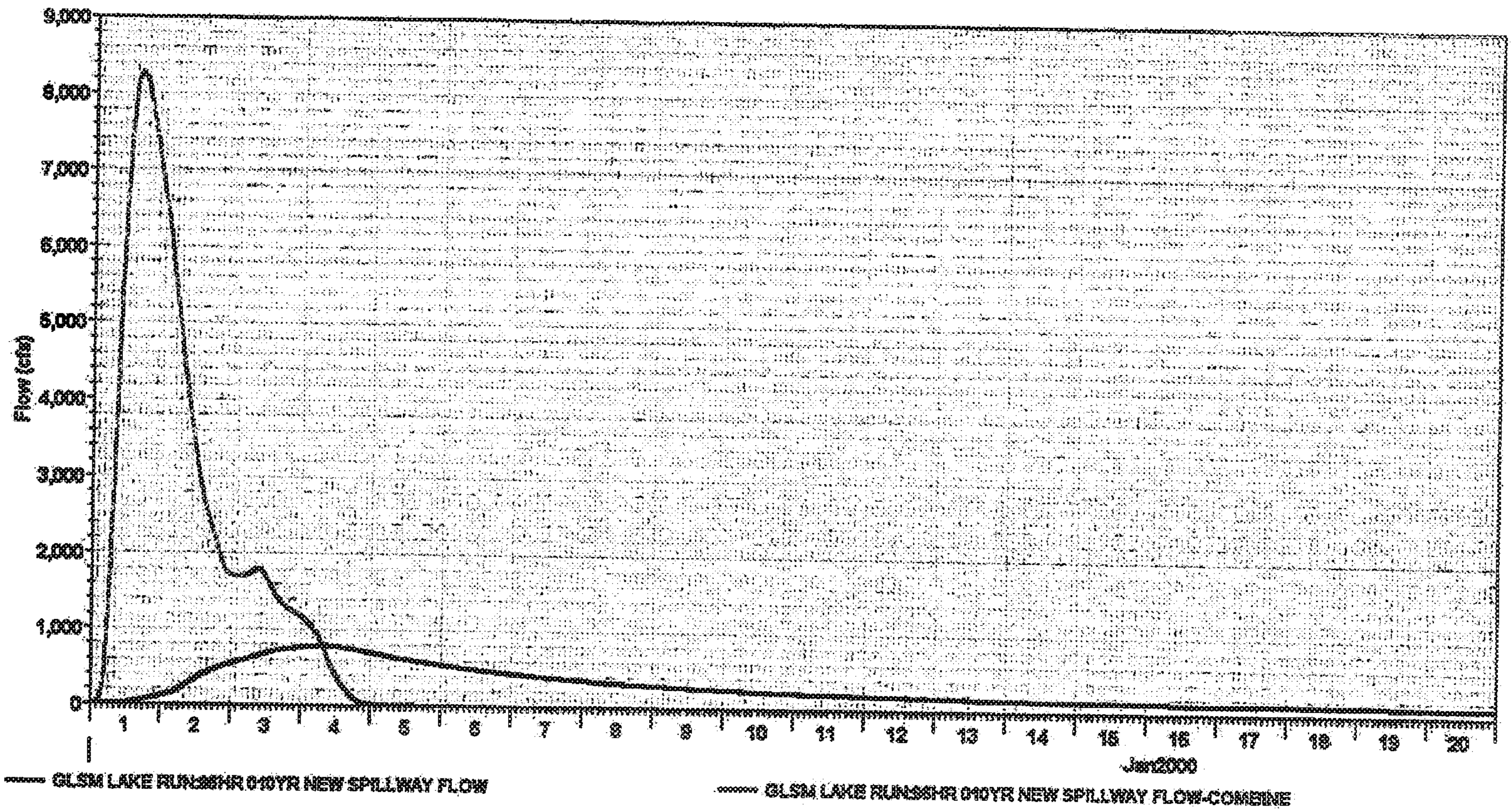

Figure 1: GLSM inflow (red) and new spillway outflow (blue), 10-year flood

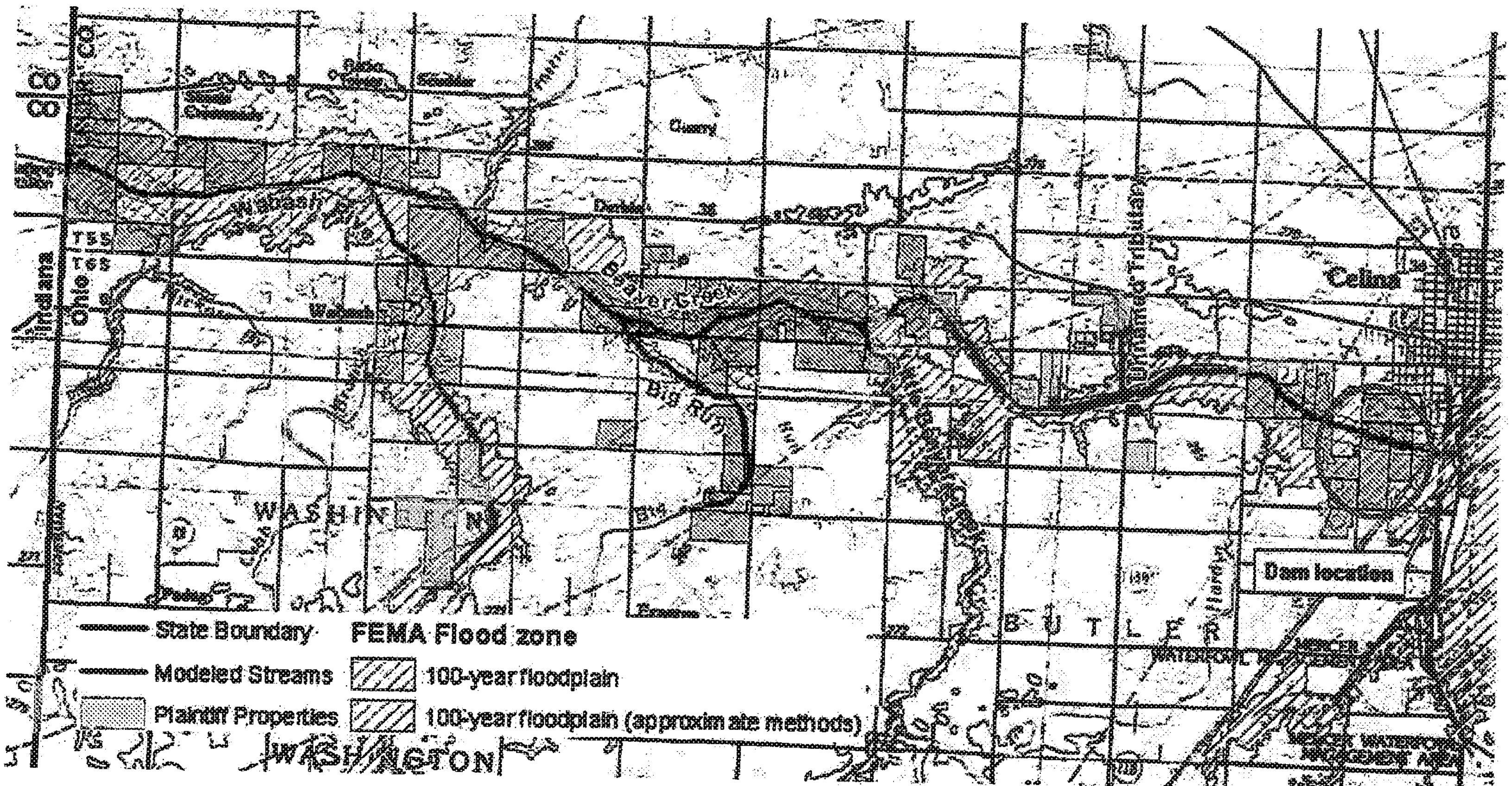

Figure 2: Beaver Creek and Wabash River study area map

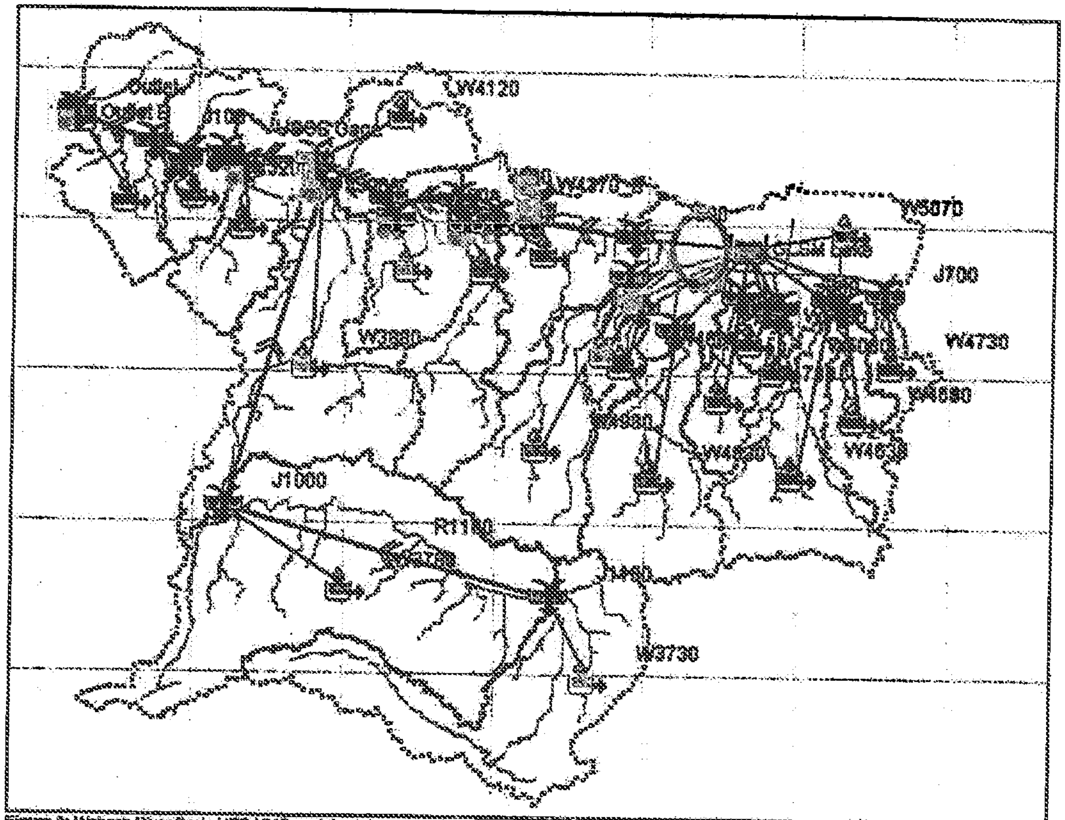

Figure 3: Wabash River Basin HEC-HMS model components

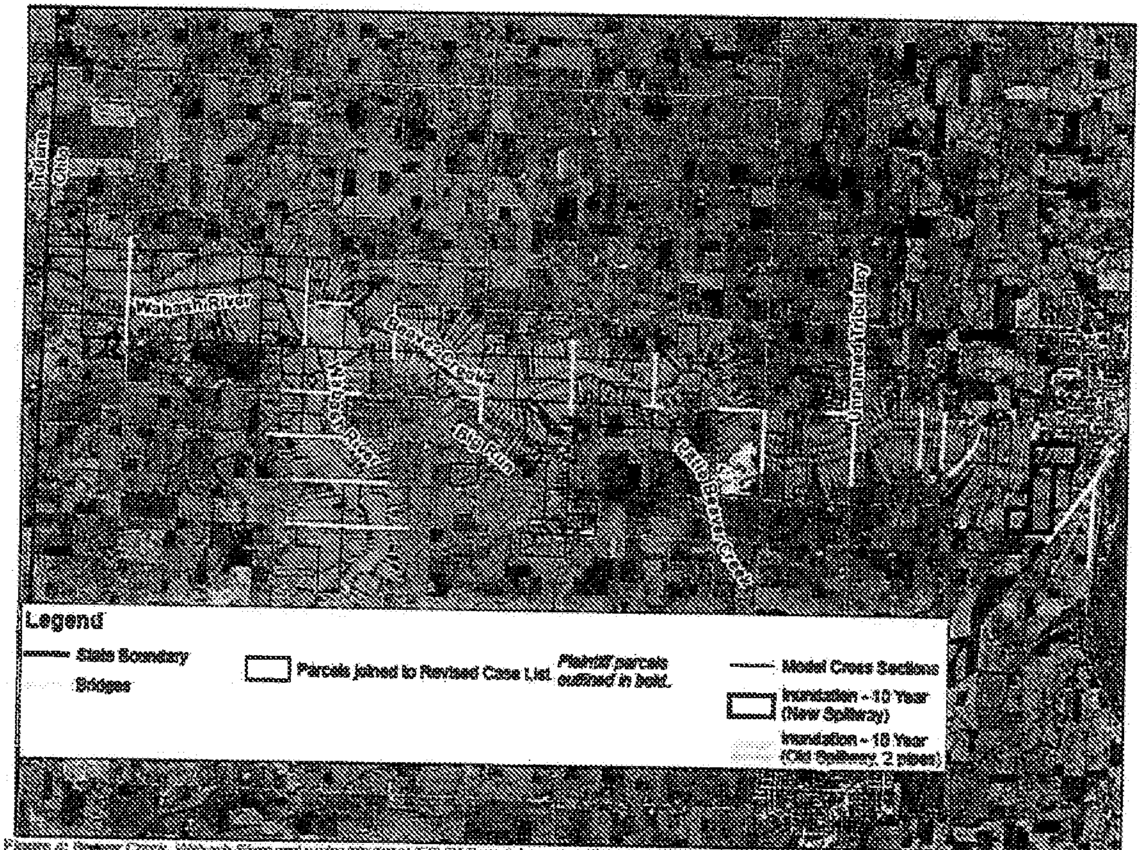

Figure 4: Beaver Creek, Wabash River and major tributary HEC-RAS model cross sections, showing location of Zumberge parcels

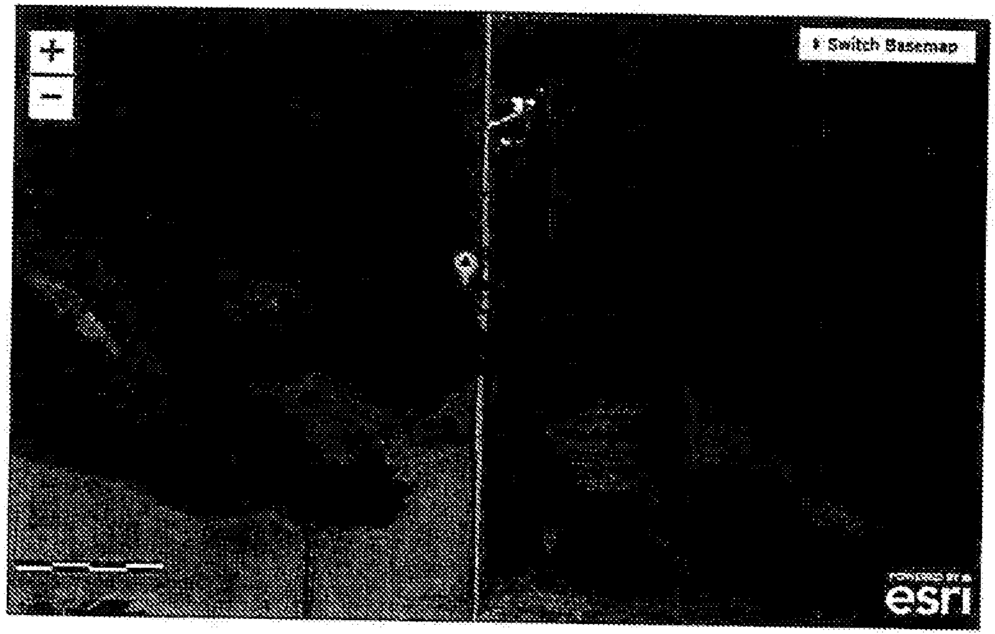

Figure 8: USGS New Croydon Gage (HEC-RAS model downstream boundary) location

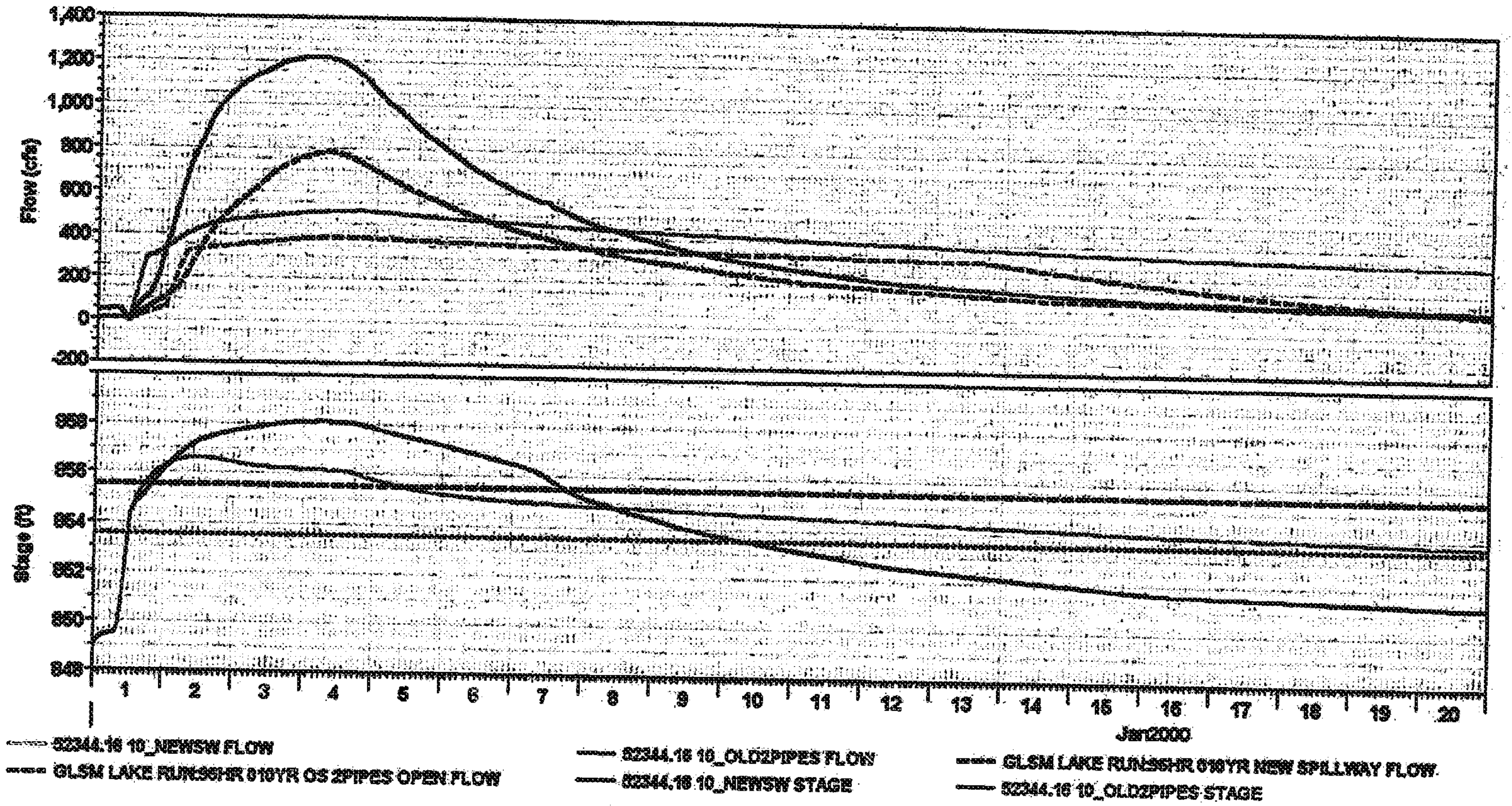

Figure 6: Simulated 10-year flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on Zumberge parcels 26-022800.0000 (northern) and 26-052800.0000 (middle), both represented by cross section 52344 (blue – new spillway, red – old spillway); black dashed line – northern parcel representative elevation (855.5); black dotted line – middle parcel representative elevation (853.5)

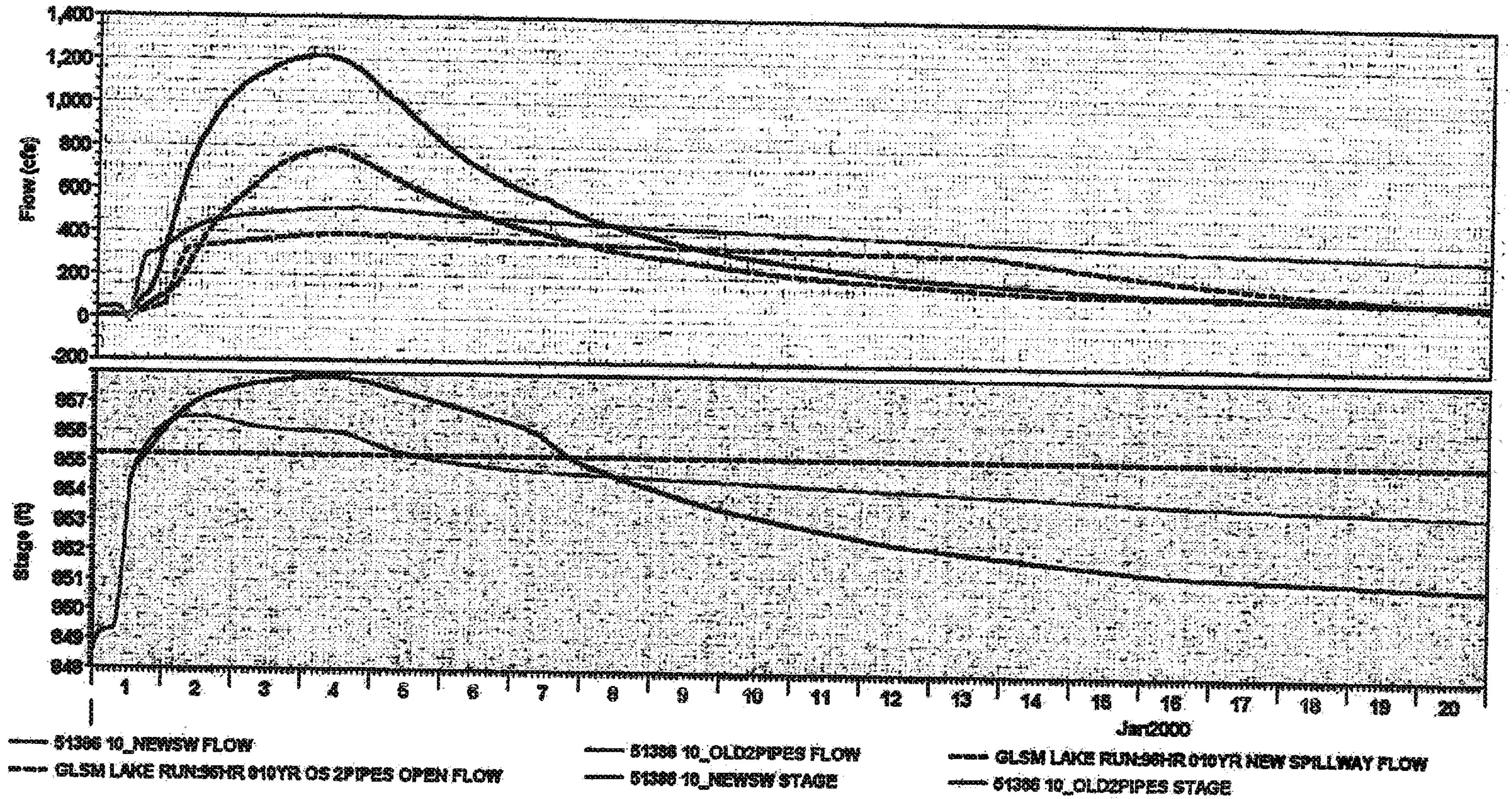

Figure 7: Simulated 10-year flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on the southern Zumbergo parcel, number 26-051000.0000, represented by cross section 51386 (blue -- new spillway, red -- old spillway); black dashed line -- parcel representative elevation (855.2)

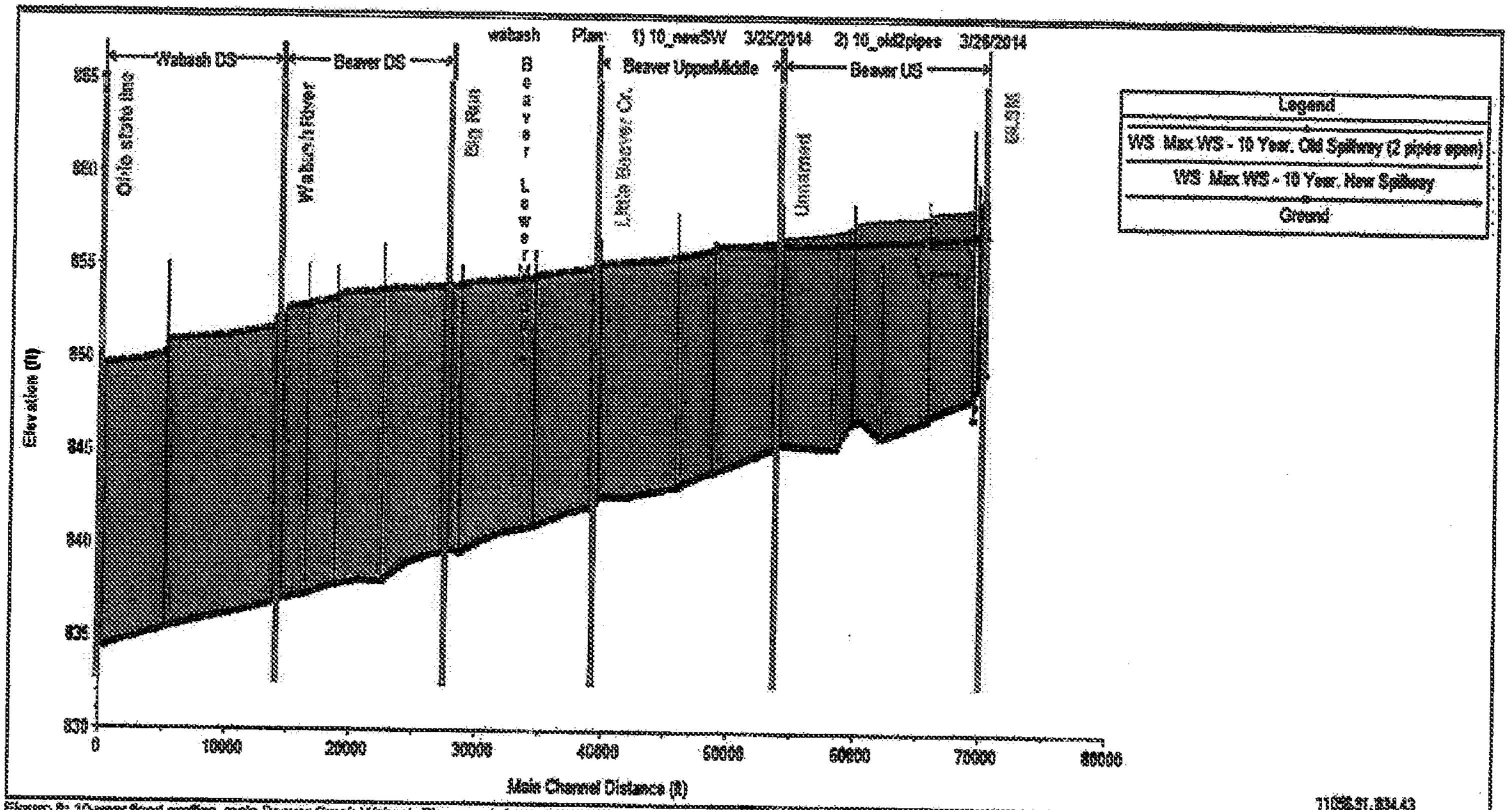

Figure 8: 10-year flood profiles, main Beaver Creek-Wabash River reach for pre- and post-1997 spillway configurations (red lines – tributary junctions; blue triangles – old spillway, solid blue line – new spillway, red arrow – Zumberge parcels)

Table 1: Selected flood statistics for Zumberge Parcel Number 25-022800.0000 (northern parcel)

	Flood event	HEC-RAS station	Peak flow(cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 855.5 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 25-022800.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 855.5 (Visually selected)	10-year	51715 51787 52068 52344 52637 53042 53282 53578 53803	514 514 514 513 512 511 510 508 507	1213 1213 1214 1215 1216 1217 1218 1218 1219	699 699 700 702 704 706 708 710 712	856.5 856.5 856.6 856.6 856.6 856.6 856.6 856.6 856.7	858.1 858.1 858.1 858.1 858.1 858.1 858.2 858.2 858.2	1.6 1.6 1.5 1.5 1.5 1.5 1.6 1.6 1.5	0.0	15.8	15.8	3.54	5.82	2.28

Table 2: Selected flood statistics for Zumberge Parcel Number 28-052900.0000 (middle parcel)

	Flood event	HEC-RAS station	Peak flow (cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 853.5 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 28-052900.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 853.5 (Levee low point)	10-year	51715	514	1213	699	856.5	858.1	1.6	28.0	70.7	42.7	19.51	8.97	-10.55
		51787	514	1213	699	856.6	858.1	1.5						
		52068	514	1214	700	856.6	858.1	1.5						
		52344	513	1215	702	856.6	858.1	1.5						
		52637	512	1216	704	856.6	858.1	1.5						
		53042	511	1217	706	856.6	858.1	1.5						
		53282	510	1218	708	856.6	858.2	1.6						
		53578	508	1218	710	856.6	858.2	1.6						
		53803	507	1219	712	856.7	858.2	1.5						
		54174	506	1221	715	856.7	858.2	1.5						
		54434	505	1222	717	856.7	858.2	1.5						

Table 3: Selected flood statistics for Zumberge Parcel Number 28-051000.0000 (southern parcel)

	Flood event	HEC-RAS station	Peak flow(cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 855.2 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 28-051000.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 855.2 (Visually selected)	10-year	50861 51142 51388 51649	516 515 514 514	1212 1213 1213 1213	696 698 699 699	856.5 856.5 856.5 856.5	857.8 857.8 857.9 857.9	1.3 1.3 1.4 1.4	0.7	1.5	0.8	3.32	5.49	2.17

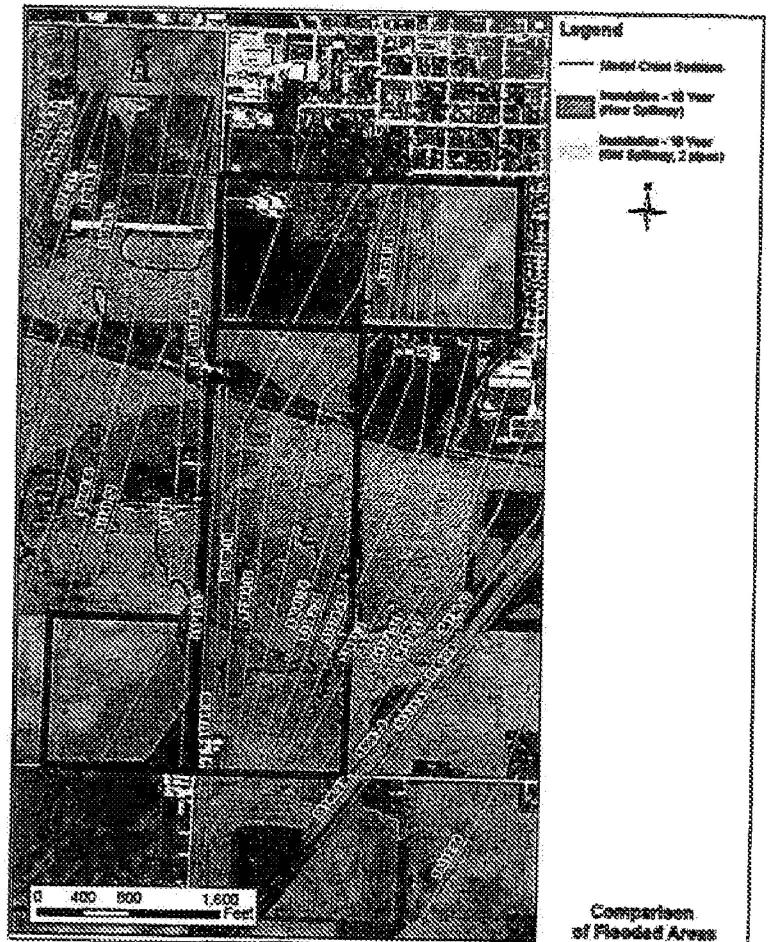

Figure 9: 10-year flood inundation map, Zumberge parcels, numbers 38-032800.0000 (northern), 38-082800.0000 (middle) and 38-051000.0000 (southern)

Table 4 - HEC-RAS 10-year flood profiles

River	Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Beaver	US	50950.84	Max WS	10_newSW	1210	846.72	857.82		857.83	0.00	1.15	2074	1424	0.06
Beaver	US	50950.84	Max WS	10_old2pipes	421	846.72	856.48		856.49	0.00	0.72	1155	871	0.05
Beaver	US	51141.92	Max WS	10_newSW	1210	846.79	857.84		857.85	0.00	1.17	1932	1503	0.06
Beaver	US	51141.92	Max WS	10_old2pipes	422	846.79	856.49		856.50	0.00	0.68	1084	468	0.05
Beaver	US	51386	Max WS	10_newSW	1211	846.86	857.88		857.91	0.00	1.80	1119	1496	0.13
Beaver	US	51386	Max WS	10_old2pipes	423	846.86	856.50		856.51	0.00	1.01	534	292	0.07
Beaver	US	51547.58	Max WS	10_newSW	1210	846.90	857.88		857.97	0.00	2.65	477	87	0.17
Beaver	US	51547.58	Max WS	10_old2pipes	423	846.90	856.51		856.53	0.00	1.09	389	80	0.07
Beaver	US	51634.92	Meyer Rd.	Bridge										
Beaver	US	51715.13	Max WS	10_newSW	1211	847.10	858.08	851.33	858.08	0.00	0.86	3528	3274	0.06
Beaver	US	51715.13	Max WS	10_old2pipes	423	847.10	856.82	849.32	856.84	0.00	1.10	383	81	0.08
Beaver	US	51786.69	Max WS	10_newSW	1211	847.12	858.08		858.09	0.00	1.09	2837	3188	0.07
Beaver	US	51786.69	Max WS	10_old2pipes	423	847.12	856.53		856.54	0.00	1.09	387	188	0.08
Beaver	US	52068.18	Max WS	10_newSW	1211	847.20	858.10		858.10	0.00	1.01	3243	2874	0.07
Beaver	US	52068.18	Max WS	10_old2pipes	424	847.20	856.55		856.57	0.00	1.09	389	140	0.08
Beaver	US	52344.16	Max WS	10_newSW	1211	847.28	858.11		858.11	0.00	0.63	4522	2682	0.04
Beaver	US	52344.16	Max WS	10_old2pipes	425	847.28	856.57		856.59	0.00	0.85	715	620	0.07
Beaver	US	52636.78	Max WS	10_newSW	1211	847.38	858.12		858.12	0.00	0.72	3887	2234	0.05
Beaver	US	52636.78	Max WS	10_old2pipes	425	847.38	856.59		856.61	0.00	1.02	542	545	0.07
Beaver	US	53041.74	Max WS	10_newSW	1211	847.47	858.13		858.14	0.00	0.97	2434	1738	0.07
Beaver	US	53041.74	Max WS	10_old2pipes	426	847.47	856.62		856.62	0.00	0.65	1333	525	0.04
Beaver	US	53282.26	Max WS	10_newSW	1212	847.54	858.18		858.18	0.00	1.23	1811	1760	0.08
Beaver	US	53282.26	Max WS	10_old2pipes	427	847.54	856.63		856.63	0.00	0.72	1024	509	0.05
Beaver	US	53578.45	Max WS	10_newSW	1212	847.62	858.18		858.19	0.00	1.16	1821	1818	0.08
Beaver	US	53578.45	Max WS	10_old2pipes	427	847.62	856.64		856.64	0.00	0.74	1055	874	0.05
Beaver	US	53803.2	Max WS	10_newSW	1213	847.68	858.20		858.20	0.00	1.01	2331	2604	0.07
Beaver	US	53803.2	Max WS	10_old2pipes	427	847.68	856.65		856.65	0.00	0.72	1068	628	0.05
Beaver	US	54174.35	Max WS	10_newSW	1213	847.73	858.22		858.23	0.00	1.05	1203	2004	0.07
Beaver	US	54174.35	Max WS	10_old2pipes	428	847.73	856.68		856.56	0.00	0.58	1079	991	0.05
Beaver	US	54434.21	Max WS	10_newSW	1213	847.88	858.24		858.26	0.00	1.18	1336	2025	0.10
Beaver	US	54434.21	Max WS	10_old2pipes	428	847.88	856.67		856.66	0.00	0.72	739	889	0.06
Beaver	US	54780.42	Max WS	10_newSW	1214	847.84	858.28		858.31	0.00	1.34	1188	2036	0.10
Beaver	US	54780.42	Max WS	10_old2pipes	428	847.84	856.68		856.70	0.00	0.79	600	861	0.07
Beaver	US	55093.8	Max WS	10_newSW	1214	848.04	858.34		858.42	0.00	2.33	621	87	0.18
Beaver	US	55093.8	Max WS	10_old2pipes	429	848.04	856.72		856.74	0.00	1.14	378	84	0.10
Beaver	US	55117.89	Rx3Road	Bridge										
Beaver	US	55148.27	Max WS	10_newSW	1216	848.09	858.43	851.93	858.51	0.00	2.22	548	100	0.17
Beaver	US	55148.27	Max WS	10_old2pipes	429	848.09	856.74	850.12	856.78	0.00	1.09	394	84	0.08
Beaver	US	55161.29	Max WS	10_newSW	1216	848.98	858.45		858.52	0.00	2.04	597	101	0.16
Beaver	US	55161.29	Max WS	10_old2pipes	428	848.28	856.75		856.76	0.00	0.97	442	84	0.07
Beaver	US	55178.88	Old RR - Bike pa	Bridge										
Beaver	US	55215.43	Max WS	10_newSW	1217	848.98	858.53	851.17	858.61	0.00	2.33	545	305	0.19
Beaver	US	55215.43	Max WS	10_old2pipes	429	848.98	856.75	849.21	856.77	0.00	1.11	385	141	0.08
Beaver	US	55312.84	Max WS	10_newSW	1217	847.98	858.82		858.84	0.00	1.34	1133	1000	0.10
Beaver	US	55312.84	Max WS	10_old2pipes	428	847.98	856.77		856.78	0.00	0.80	883	403	0.07
Beaver	US	55428.83	Max WS	10_newSW	1217	848.54	858.59		858.67	0.00	2.15	568	849	0.14
Beaver	US	55428.83	Max WS	10_old2pipes	429	848.54	856.77		856.79	0.00	0.89	432	364	0.07
Beaver	US	55481.62	US 127	Bridge										
Beaver	US	55533.63	Max WS	10_newSW	1219	848.58	858.68	852.65	858.74	0.00	3.08	614	978	0.15
Beaver	US	55533.63	Max WS	10_old2pipes	429	848.58	856.78	850.81	856.81	0.00	1.09	328	400	0.10
Beaver	US	55870.66	Max WS	10_newSW	1219	848.75	858.75		858.77	0.00	1.30	1231	1458	0.10
Beaver	US	55870.66	Max WS	10_old2pipes	430	848.75	856.81		856.82	0.00	1.01	426	102	0.09
Beaver	US	55848.93	Max WS	10_newSW	1219	849.00	858.78		858.79	0.00	0.85	2129	1678	0.07
Beaver	US	55848.93	Max WS	10_old2pipes	430	849.00	856.83		856.84	0.00	1.08	397	87	0.08
Beaver	US	56213.97	Max WS	10_newSW	1220	849.50	858.81		858.89	0.00	2.22	548	88	0.16
Beaver	US	56213.97	Max WS	10_old2pipes	430	849.50	856.87		856.88	0.00	1.13	382	82	0.09
Big Run	Big Run	254.2123	Max WS	10_newSW	245	839.72	853.93		853.93	0.00	0.25	1478	771	0.02
Big Run	Big Run	254.2123	Max WS	10_old2pipes	266	839.72	853.94		853.94	0.00	0.27	1481	771	0.02
Big Run	Big Run	494.3325	Max WS	10_newSW	242	840.98	853.93		853.93	0.00	0.30	1181	833	0.02

Ohio Department of Natural Resources

Flood Impacts of Spillway Improvements July 2003 Flood

Charles and Jennifer Zumberge Parcels
Parcel Numbers 26-022600.0000, 26-051000.0000 and 26-052900.0000

Grand Lake Saint Marys,
Beaver Creek and Wabash River

April 2014

ARCADIS
Infrastructure Water Environment Buildings

EXHIBIT
2

1. Purpose and scope

This report summarizes impacts on flooding of the Jerry and Betty Zumberge parcels due to improvements to the Grand Lake St. Mary's (GLSM) Dam spillway. The spillway crest length was increased in 1997 to bring the dam into compliance with Ohio Dam Safety Laws and Regulations (ORC Title XV as amended).

Impacts of spillway improvements on flooding were determined by hydrologic and hydraulic modeling of basin response to a flood event resulting from heavy precipitation occurring from July 4 through July 8, 2003. Flood levels on individual parcels were determined by hydrologic and hydraulic modeling as subsequently described. Total recorded event precipitation depths at the four functioning National Oceanic and Atmospheric Administration (NOAA) gages closest to the watershed ranged from 6 to 11 inches. These data were adjusted using National Weather Service (NWS) NEXRAD radar spatial distribution information. Total July 4-8 rainfall depth averaged over the Wabash River basin upstream of the Ohio state line, including Grand Lake Saint Marys and Beaver Creek, was 7.65 inches. The most intense 96-hour period during the event produced 7.25 inches of rainfall, with a return period of approximately 176 years, estimated based on NOAA Atlas 14[1] regional 96-hour precipitation depth.

The simulation period for the 2003 flood analysis was extended to a full month – from July 2 through August 2 – because inflow to GLSM is stored and released over the spillway over a long period of time. Due to its smaller discharge capacity, lake level recedes more slowly with the old spillway in operation than with the new spillway. Because GLSM spillway operation has been uncontrolled (free overflow) following spillway modification in 1997, reservoir outflow is always less than the peak rate of inflow, illustrated in the case of the 2003 flood in Figure 1. Consequently, no matter the temporal and spatial distribution of rainfall within the GLSM watershed, peak flood level on any specific parcel downstream of GLSM will always be lower with the new spillway in operation than would occur naturally, i.e. if GLSM did not exist.

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[1] NOAA Atlas 14, National Weather Service Hydro meteorological Design Studies Center, Precipitation Frequency Data Server (PFDS) http://hdsc.nws.noaa.gov/hdsc/pfds/index.html

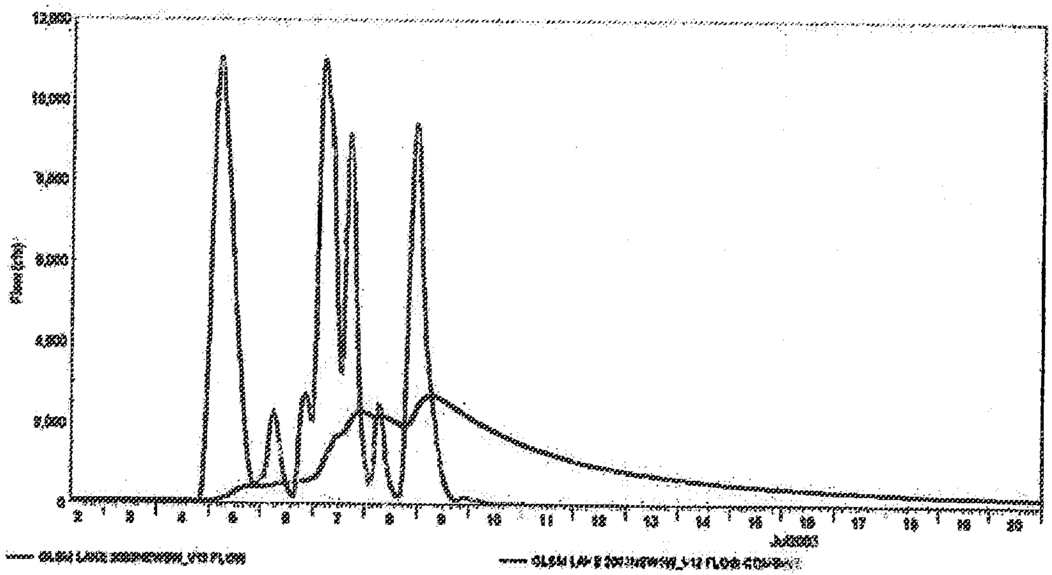

Figure 1: GLSM inflow (red) and new spillway outflow (blue), July 2003 flood

Rainfall-runoff modeling was performed using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), version 3.5. HEC-HMS is a generalized computer program that simulates precipitation-runoff processes of dendritic river basins and reservoir systems.

Computed inflow to GLSM for the July 2003 flood was routed through the reservoir and dam for the pre-1997 and post-1997 spillway based on the following assumptions:

- Releases over the pre-1997 spillway with two of the four gated low-level outlets opened 24 inches (out of a possible 32 inches) when GLSM reservoir level exceeds 871.1, one foot above spillway crest; operation consistent with standard operating procedures and the maintenance condition of the gates prior to construction of the new spillway in 1997

- Free-overflow releases from the improved (post-1997) spillway

Grand Lake St. Marys outflow time series generated by HEC-HMS were combined with subbasin runoff hydrographs, and routed (one-dimensional unsteady flow routing) through the main channel and principal tributaries of Beaver Creek and the Wabash River downstream of GLSM using the HEC-RAS (River Analysis System) model, version 4.1.0. The model domain extends from the GLSM spillway west to the Ohio-Indiana border, including reaches of Beaver Creek, Wabash River, Big Run, Little Beaver Creek, and an unnamed tributary. Figure 2 displays a study area map with modeled streams, approximate location of plaintiff's properties and the FEMA 100-year flood zone.

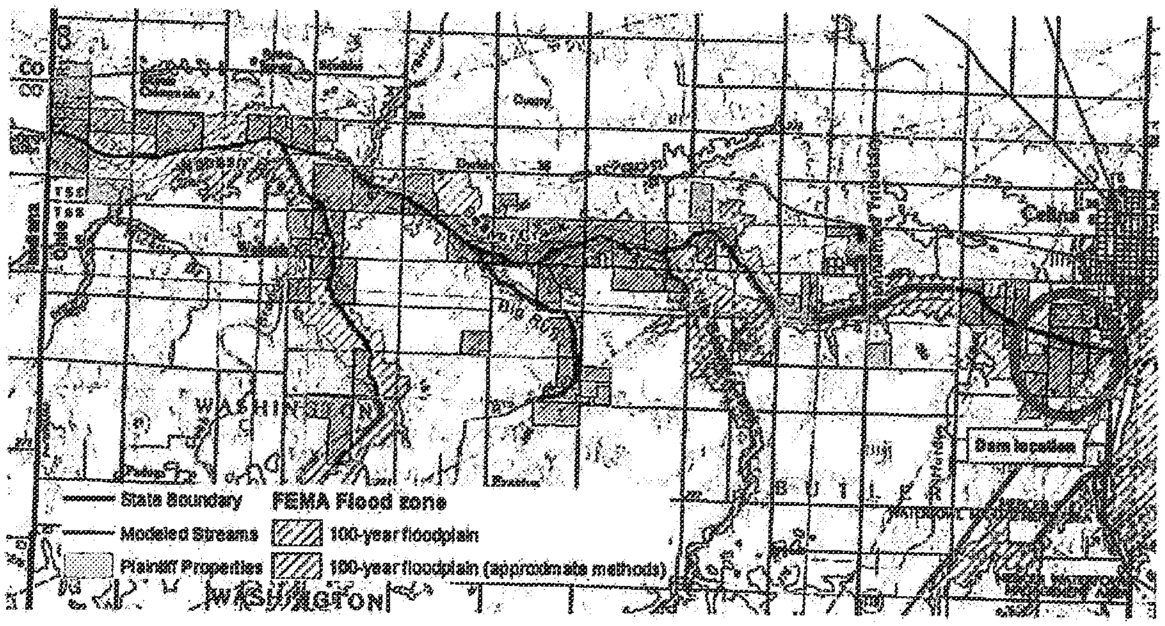

Figure 2: Beaver Creek and Wabash River study area map

The HEC-HMS model encompasses the entire watershed draining to the Wabash River above the Ohio-Indiana line; the model domain and major components are shown in Figure 3.

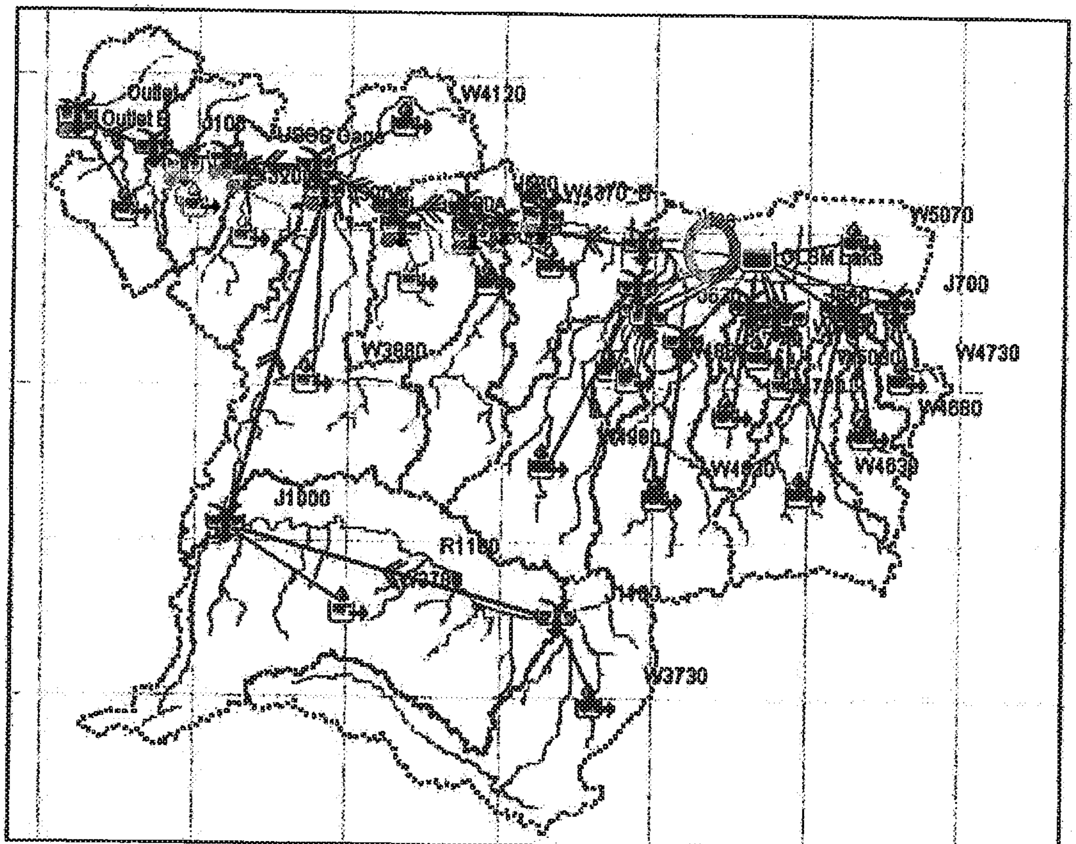

Figure 3: Wabash River Basin HEC-HMS model components

The extent of hydraulic (HEC-RAS) modeling is based on the location of plaintiffs' properties along the main stream receiving flow from the dam, Beaver Creek and Wabash River below Beaver Creek, and major tributaries. While several tributaries contribute flow to the main receiving channel, only tributaries with plaintiffs affected by tributary flooding were explicitly modeled using HEC-RAS cross sections. The HEC-RAS model, shown in overview in Figure 4 is high resolution with closely-spaced cross sections, a total of 15 of which traverse the three Zumberge parcels, numbered 26-022600.0000 (northern), 26-052900.0000 (middle) and 26-051000.0000 (southern).

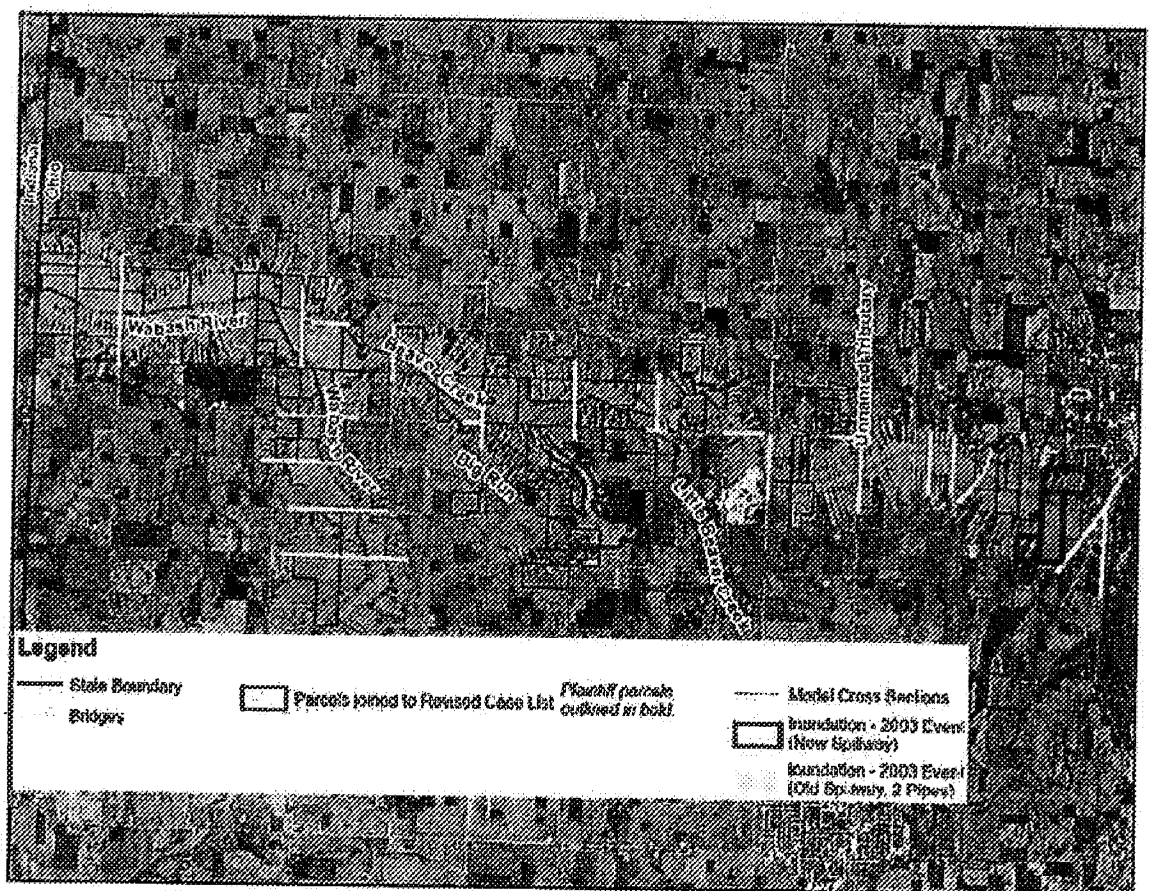

Figure 4: Beaver Creek, Wabash River and major tributary HEC-RAS model cross sections, showing location of Zumberge parcels

The downstream boundary of the hydraulic model is located just upstream of the Ohio-Indiana border. A rating curve was used as the downstream boundary, developed based on historic records for the USGS New Corydon Gage and extrapolated to extreme high-flow events. Extrapolation was performed by non-linear regression of HEC-RAS model-computed stages downstream of the bridge at State Line Road, over a range of steady (non time-varying) flows. The New Corydon Gage is located as shown in Figure 5.

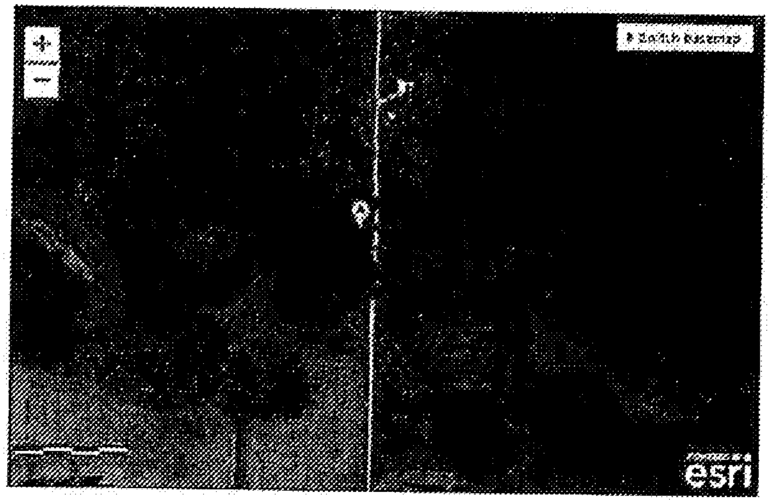

Figure 6: USGS New Corydon Gage (HEC-RAS model downstream boundary) location

2. Parcel location

The Zumberge parcels (26-022600.0000, 26-052900.0000 and 26-051000.0000) are located respectively on the north side, across and on the south side of Beaver Creek just downstream of the GLSM spillway – the upstream HEC-RAS model boundary. The parcels are shown in overview in Figure 4 and enlarged in Figure 10.

3. Analysis results – effects of GLSM spillway improvements

Hydrologic and hydraulic simulation results presented in this report enable comparisons of flood impacts of pre- and post-1997 GLSM spillway operation for the July 2003 flood. The following information is provided:

- Flood propagation, i.e. change in magnitude and timing of flood flow moving downstream from the GLSM spillway and associated flood stage at the midpoint of each of the Zumberge parcels
- Flood statistics, i.e. peak flow, elevation, flooded area and duration
- Flood inundation mapping

Flood information is presented in graphical and tabular format in subsequent sections of this report.

3.1 Flood propagation

Figure 6 shows GLSM discharge and Beaver Creek flow and stage at the mid-point of the northern and middle Zumberge parcels (numbers 26-022600.0000 and 26-052900.0000) for the July 2003 flood with old and new spillways. Both parcels are represented by HEC-RAS model cross section 52344. Cross-section number in this case indicates distance (in feet) moving upstream from the Beaver Creek confluence with the Wabash River, with GLSM dam located at the most upstream cross section, number 56214.

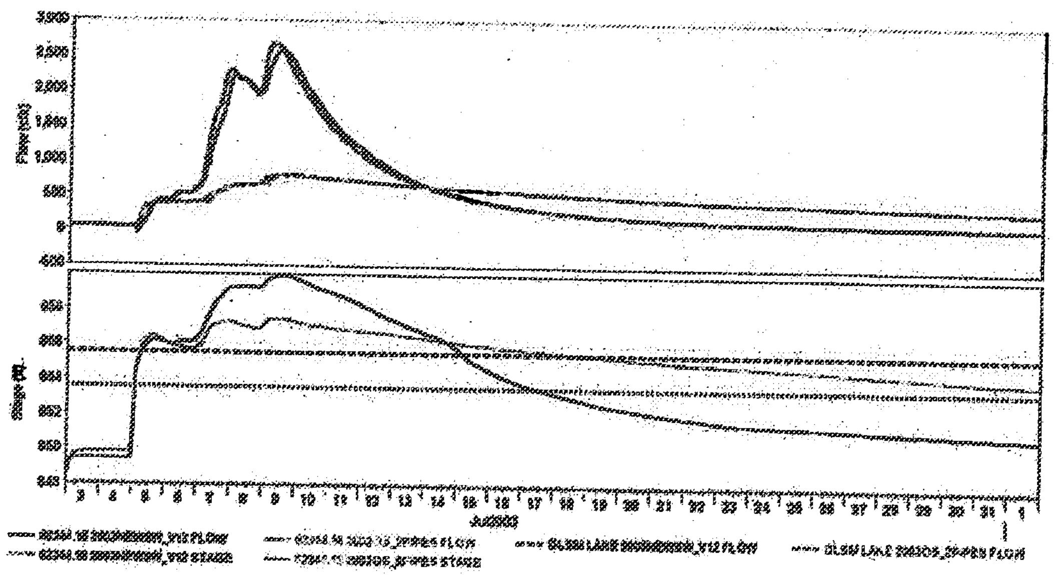

Figure 6: Simulated July 2003 flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on Zumberge parcels 26-022600.0000 (northern) and 26-052900.0000 (middle), both represented by cross section 52344 (blue – new spillway, red – old spillway); black dashed line – northern parcel representative elevation (855.5); black dotted line – middle parcel representative elevation (853.5)

Figure 7 shows GLSM discharge and Beaver Creek flow and stage on the southern Zumberge parcel (26-051000.0000) for the July 2003 flood with old and new spillways. The parcel is represented by HEC-RAS model cross section 51388. Cross-section number indicates distance (in feet) moving upstream from the Beaver Creek confluence with the Wabash River, with GLSM dam located at cross section 56214.

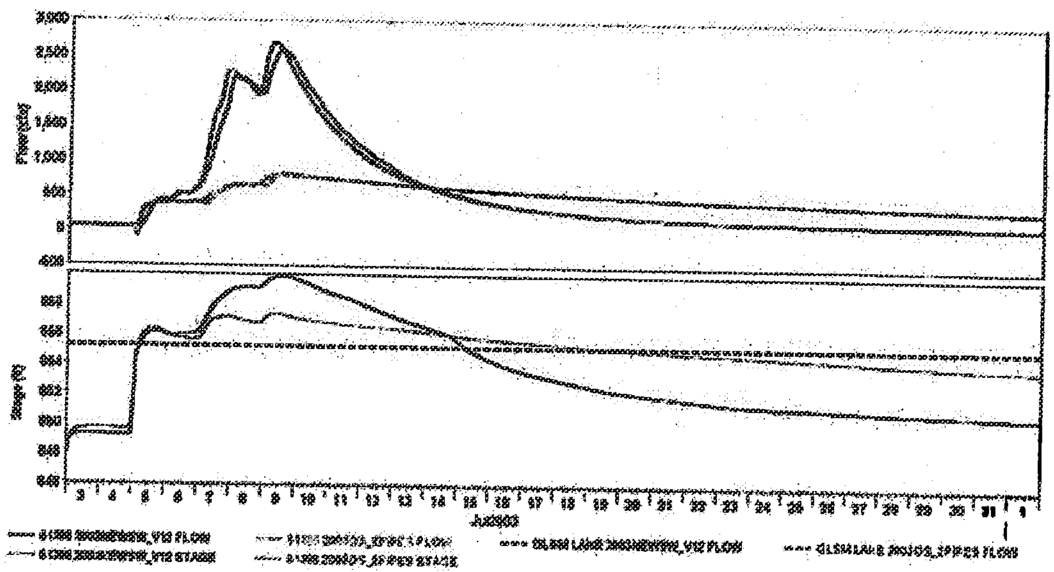

Figure 7: Simulated July 2003 flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on the southern Zumberge parcel, number 26-051000.0000, represented by cross section 51388 (blue – new spillway, red – old spillway); black dashed line – parcel representative elevation (855.2)

Flood profiles, showing peak water surface elevations in the main Beaver Creek-Wabash River reach for the pre- and post-1997 spillway configurations, are plotted in Figure 8. The relative location of the Zumberge parcels, denoted by a red arrow, is on Beaver Creek less than a mile downstream of the GLSM spillway. Due to their proximity to the upstream model boundary, all three parcels experience greater depth of flooding and greater flooded area as well. Summary HEC-RAS model results for sections crossing and in the vicinity of the Zumberge parcels are shown in Table 4 of the Appendix.

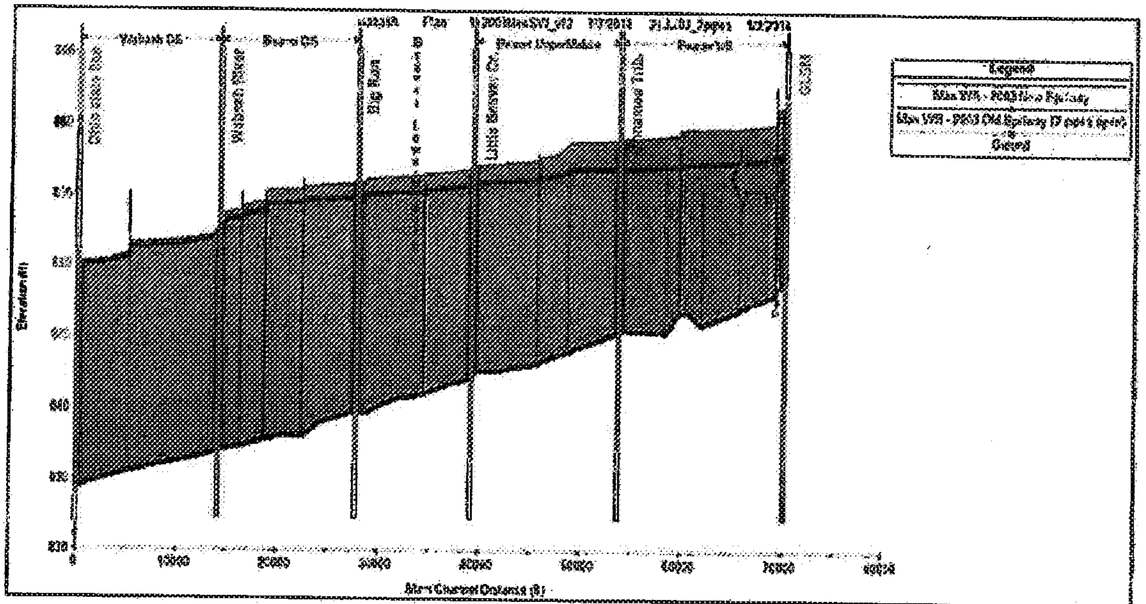

Figure 8: July 2003 flood profiles, main Beaver Creek-Wabash River reach for pre- and post-1997 spillway configurations (red lines – tributary junctions; blue triangles – old spillway, solid blue line – new spillway, red arrow – Zumberge parcels)

3.2 Flood statistics

Selected statistics for the 2003 flood are presented in Table 1 for the northern Zumberge property (parcel 26-022600.0000), Table 2 for the southern parcel (26-051000.0000) and Table 3 for the middle parcel (26-052900.0000). Due to their location near the GLSM spillway, the post-1997 spillway improvements significantly increase peak flood levels and flooded area on all three parcels. However, flood duration is much shorter with the new spillway because the parcels are sufficiently low that they are flooded for the additional days needed to lower the reservoir using the old spillway. As shown in Figures 6 and 7, Beaver Creek peak flow past the parcels is determined almost entirely by flow over the GLSM spillway.

Table 1: Selected flood statistics for Zumberge Parcel Number 26-022800.0000 (northern parcel)

	Flood event	HEC-RAS station	Peak flow (cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 855.5 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 26-022800.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 855.5 (Visually selected)	July 2003	81718	810	2558	1747	857.4	859.9	2.5	10.3	33.6	23.3	13.43	9.36	-4.09
		81787	808	2557	1749	857.4	859.9	2.5						
		82068	801	2560	1759	857.4	859.9	2.4						
		82344	797	2564	1767	857.5	859.9	2.4						
		82637	784	2558	1774	857.5	859.9	2.4						
		83042	789	2573	1784	857.5	859.9	2.4						
		83282	788	2575	1787	857.5	859.9	2.4						
		83578	787	2579	1792	857.5	860.0	2.5						
		83893	786	2583	1797	857.5	860.0	2.5						

Table 2: Selected flood statistics for Zumberge Parcel Number 26-052800.0000 (middle parcel)

	Flood event	HEC-RAS station	Peak flow (cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 853.5 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 26-052800.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 853.5 (Levee low point)	July 2003	81718	810	2558	1747	857.4	859.9	2.5	21.3	112.5	91.2	28.82	13.61	-15.23
		81787	808	2557	1749	857.4	859.9	2.5						
		82068	801	2560	1759	857.4	859.9	2.4						
		82344	797	2564	1767	857.5	859.9	2.4						
		82637	784	2558	1774	857.5	859.9	2.4						
		83042	789	2573	1784	857.5	859.9	2.4						
		83282	788	2575	1787	857.5	859.9	2.4						
		83578	787	2579	1792	857.5	860.0	2.5						
		83893	786	2583	1797	857.5	860.0	2.5						
		84174	784	2588	1804	857.5	860.0	2.4						
		84434	782	2603	1818	857.5	860.0	2.6						

Table 3: Selected flood statistics for Zumberge Parcel Number 28-051000.0000 (southern parcel)

	Flood event	HEC-RAS station	Peak flow (cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 856.2 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 28-051000.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 856.2 (Visually selected)	July 2003	60961 61143 61386 61648	813 812 810 819	2550 2552 2545 2556	1736 1741 1744 1747	857.3 857.3 857.3 857.3	859.8 859.8 859.8 859.8	2.5 2.5 2.5 2.5	0.6	22.4	21.8	14.42	10.00	-4.42

3.3 Inundation map

Figure 9 shows inundated area for the July 2003 flood on the Zumberge parcels for pre- and post 1997 spillway configurations.

Figure 9: July 2003 flood inundation map, Zumberge parcels, numbers 26-022800.0000 (northern), 26-052900.0000 (middle) and 26-051000.0000 (southern)

4. Effects of spillway improvements on frequency of flooding

Precipitation depths for NOAA Atlas 14 (previously cited) 1-, 2-, 5-, 25-, 50-, 100- and 500-year 96-hour storm events were applied to (1) determine effects of GLSM spillway improvements on frequency of flooding of the Zumberge parcels, and (2) estimate the return period of the 2003 flood on the parcel based on simulated peak stage for the multiple 96-hour storm events. These objectives were accomplished using the following procedures:

- Basinwide rainfall-runoff modeling and routing through the GLSM reservoir and dam of the multiple 96-hour storm events, with (1) two low-level outlets opened 24 inches to augment pre-1997 (old) spillway releases when lake level rises more than one foot above spillway crest (870.1), and (2) free-overflow operation of the post-1997 (new) spillway, using HEC-HMS

- Dynamic combining and routing, using HEC-RAS, of HMS-calculated GLSM spillway releases and subbasin runoff hydrographs to determine peak stage on the Zumberge parcels for the 96-hour storm events

- Comparison of RAS-calculated 2003 and 96-hour storm event peak flood stages on the Zumberge parcels

The results of the analysis are shown in Figures 10 and 11.

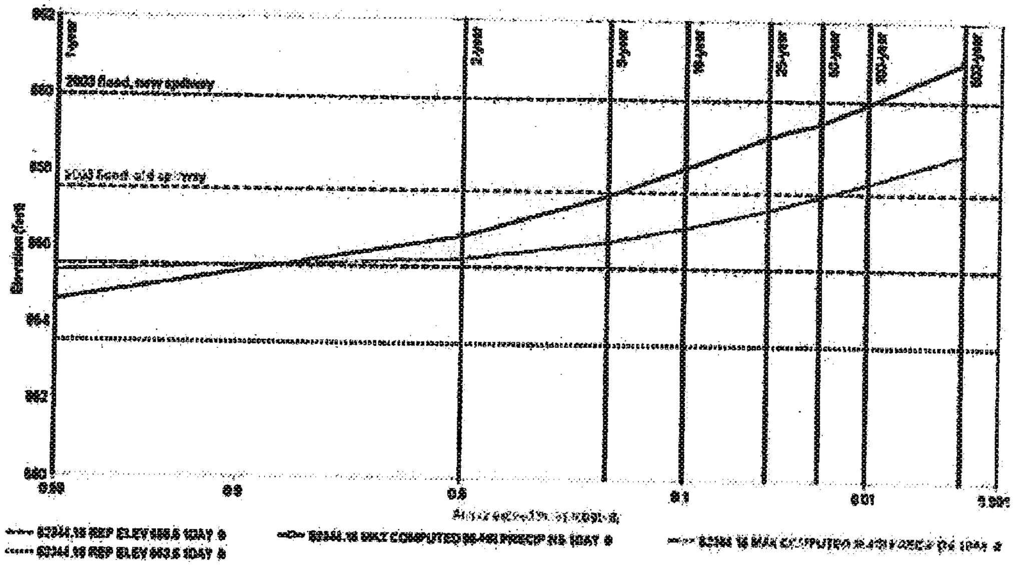

Figure 10: Zumberge northern and middle parcels (26-022600.0000 and 26-052900.0000) flood-frequency data, represented by cross section 52344: Solid blue line with markers – new spillway; solid red line with markers – old spillway; dashed blue line – 2003 peak flood elevation, new spillway; dashed red line – 2003 peak flood elevation, old spillway; dashed black line – parcel 26-022600.0000 representative elevation (855.5); dotted black line – parcel 26-052900.0000 representative elevation (853.5); vertical black lines – estimated return period in years (1 year – 500 years)

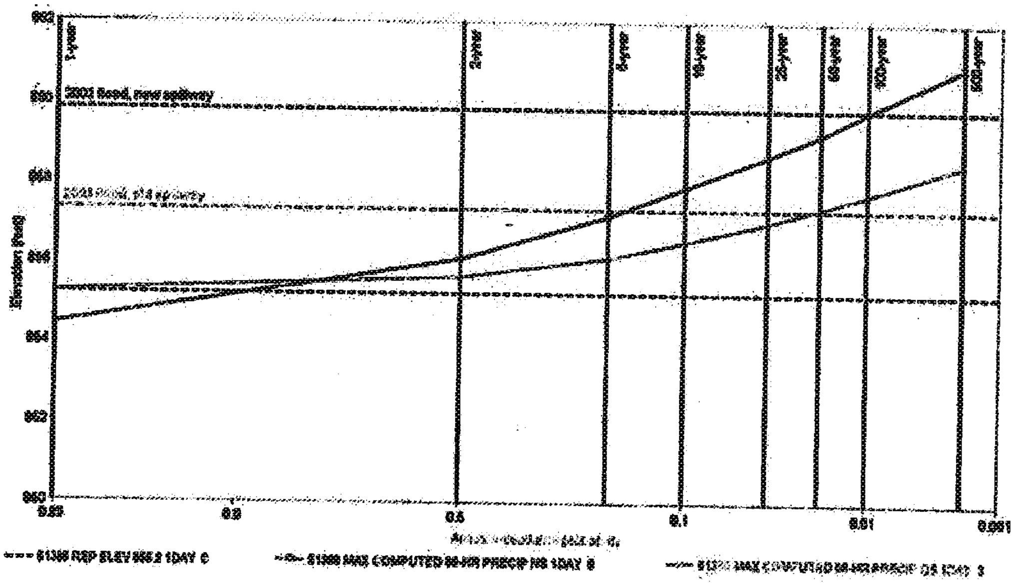

Figure 11: Zumberge southern parcel (26-051000.0000) flood-frequency data, represented by cross section 51386: Solid blue line with markers – new spillway; solid red line with markers – old spillway; dashed blue line – 2003 peak flood elevation, new spillway; dashed red line – 2003 peak flood elevation, old spillway; dashed black line – parcel 26-051000.0000 representative elevation (855.2); vertical black lines – estimated return period in years (1 year – 500 years)

The analysis shows that the new spillway significantly affects frequency of flooding of the Zumberge for synthetic rainfall events uniformly distributed throughout the watershed. The new spillway reduces flood depths for the more frequent events (less than 2-year recurrence interval) while increasing flood depths in comparison to the old spillway for events with recurrence intervals greater than 2 years.

As stated previously, the return period estimated for the 2003 flood precipitation event was 176 years. However, Figures 10 and 11 show peak flood levels on the Zumberge parcels for the 2003 flood occur at about 50 and 100-year intervals, respectively, for the old and new spillways. This is because rainfall depth is only one of many determinants of peak flood level – others in this case including (1) temporal and spatial distribution of rainfall above and below GLSM, (2) GLSM flood storage, (3) magnitude and timing of GLSM releases, and (4) hydraulic conveyance and floodplain storage downstream of GLSM. The 2003 flood resulted from a succession of smaller but significant rainfall events that combined to fill the reservoir, resulting in about 2.5 feet of additional flooding on the Zumberge parcels with the new spillway in comparison to the old spillway.

5. Conclusions

This study shows that the Zumberge parcels are significantly affected by the new spillway due to their location less than a mile downstream. All parcels experience increased flood depths on the order of 2.5 feet. Tables 1-3 show increased flooded area of approximately 23, 61 and 22 acres on the northern, middle and southern parcels (numbers 26-022600.0000, 26-052900.0000 and 26-051000.0000 respectively). However, the new spillway significantly reduces flood duration on the parcels by amounts ranging from less than 4 to more than 16 days, due to the much shorter time required to lower GLSM reservoir.

Appendix

Figures and Tables

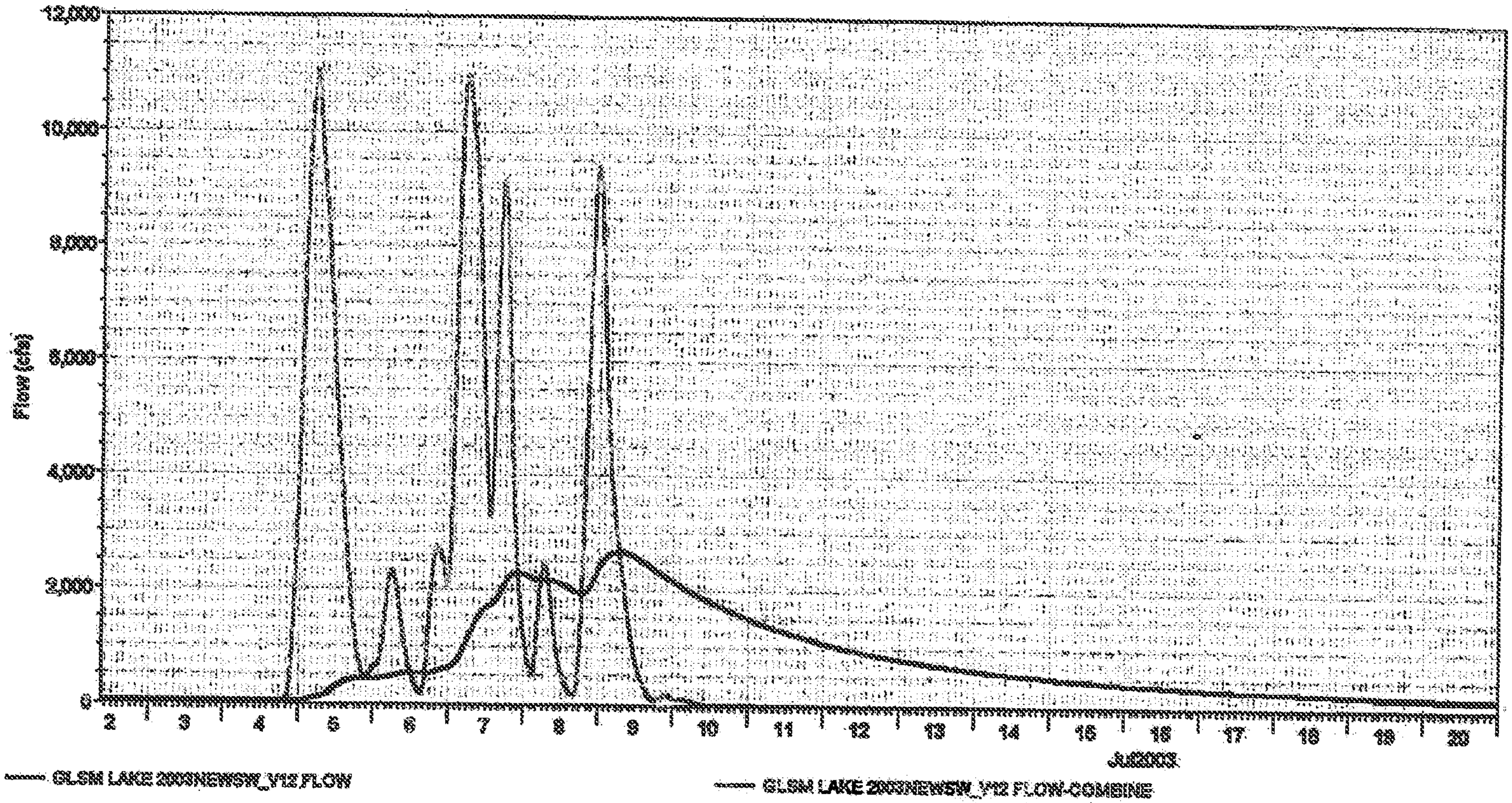

Figure 1: GLSM inflow (red) and new spillway outflow (blue), July 2003 flood

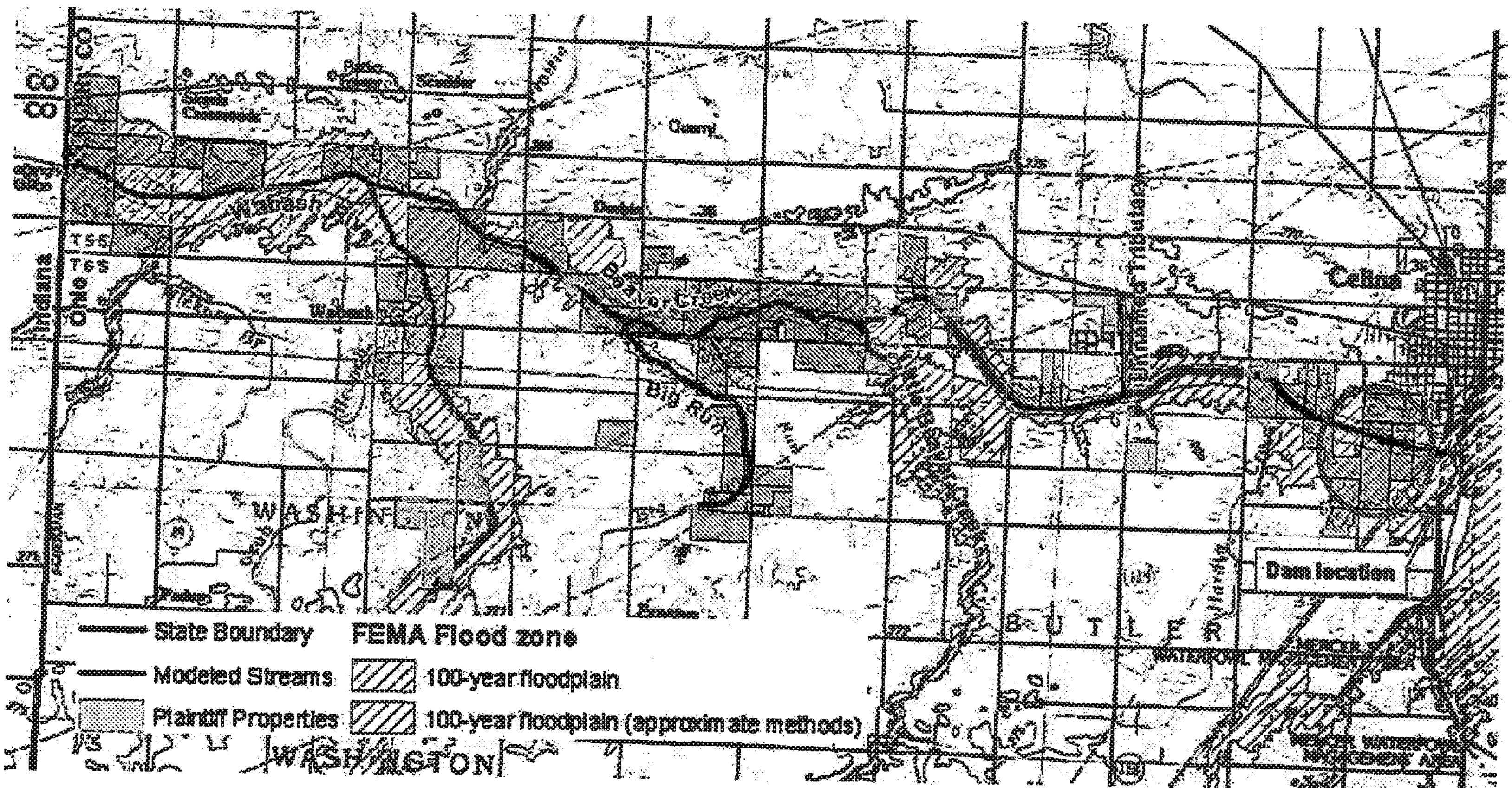

Figure 3: Beaver Creek and Wabash River study area map

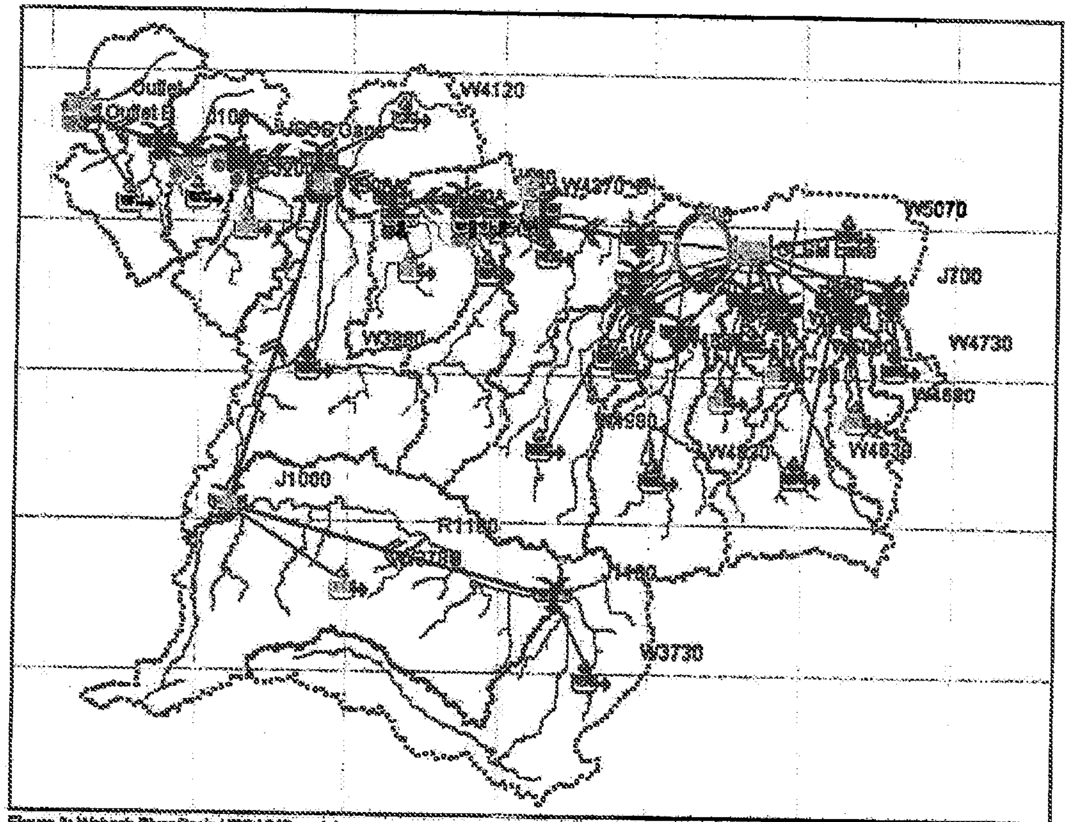

Figure 3: Wabash River Basin HEC-HMS model components

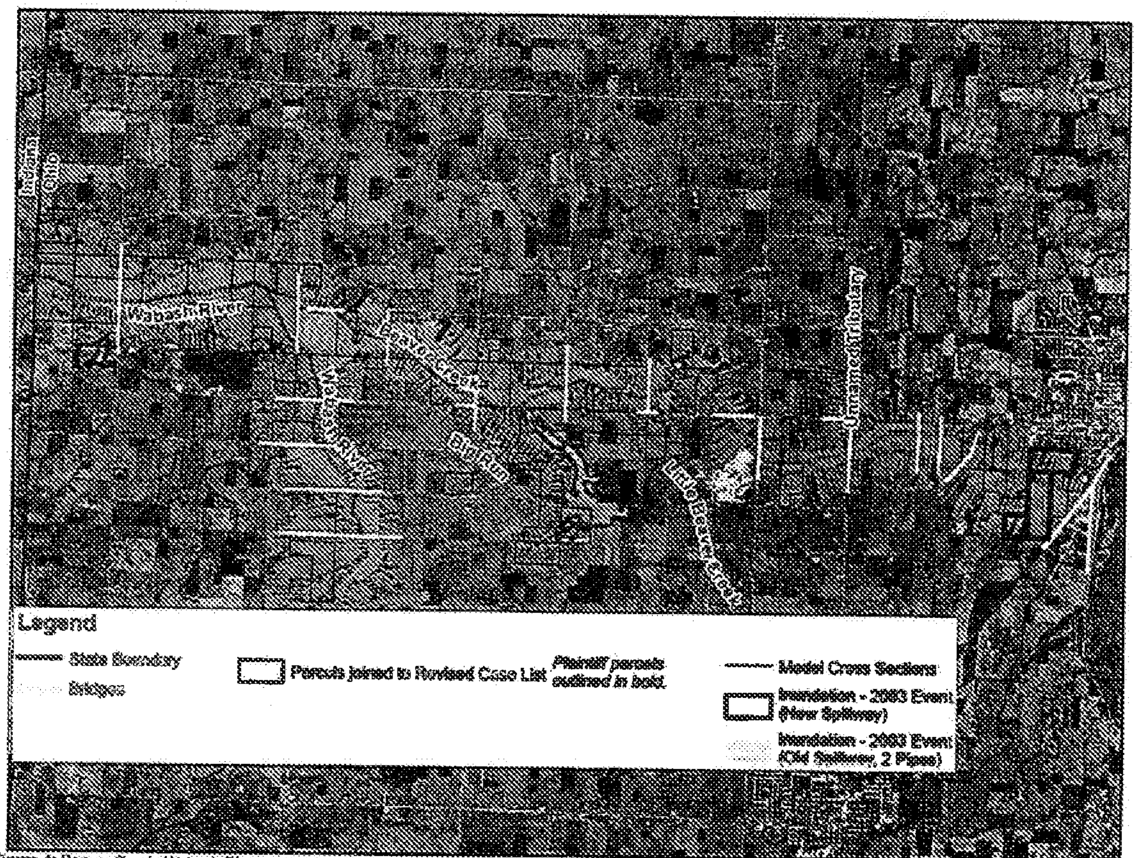

Figure 4: Beaver Creek, Wabash River and major tributary HEC-RAS model cross sections, showing location of Zumberge parcels

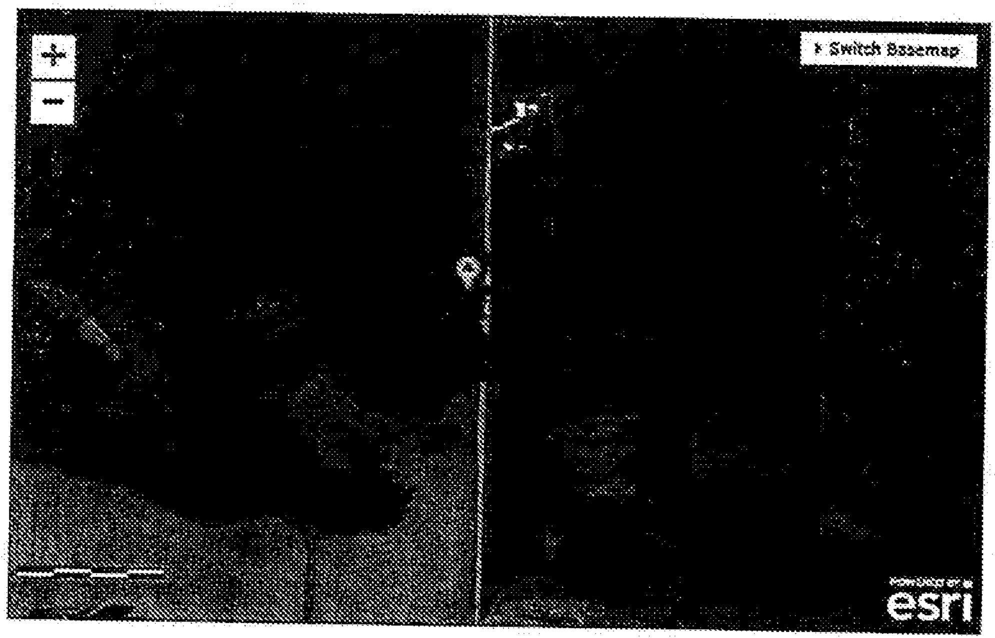

Figure 5: USGS New Canyon Gage (HEC-RAS model downstream boundary) location

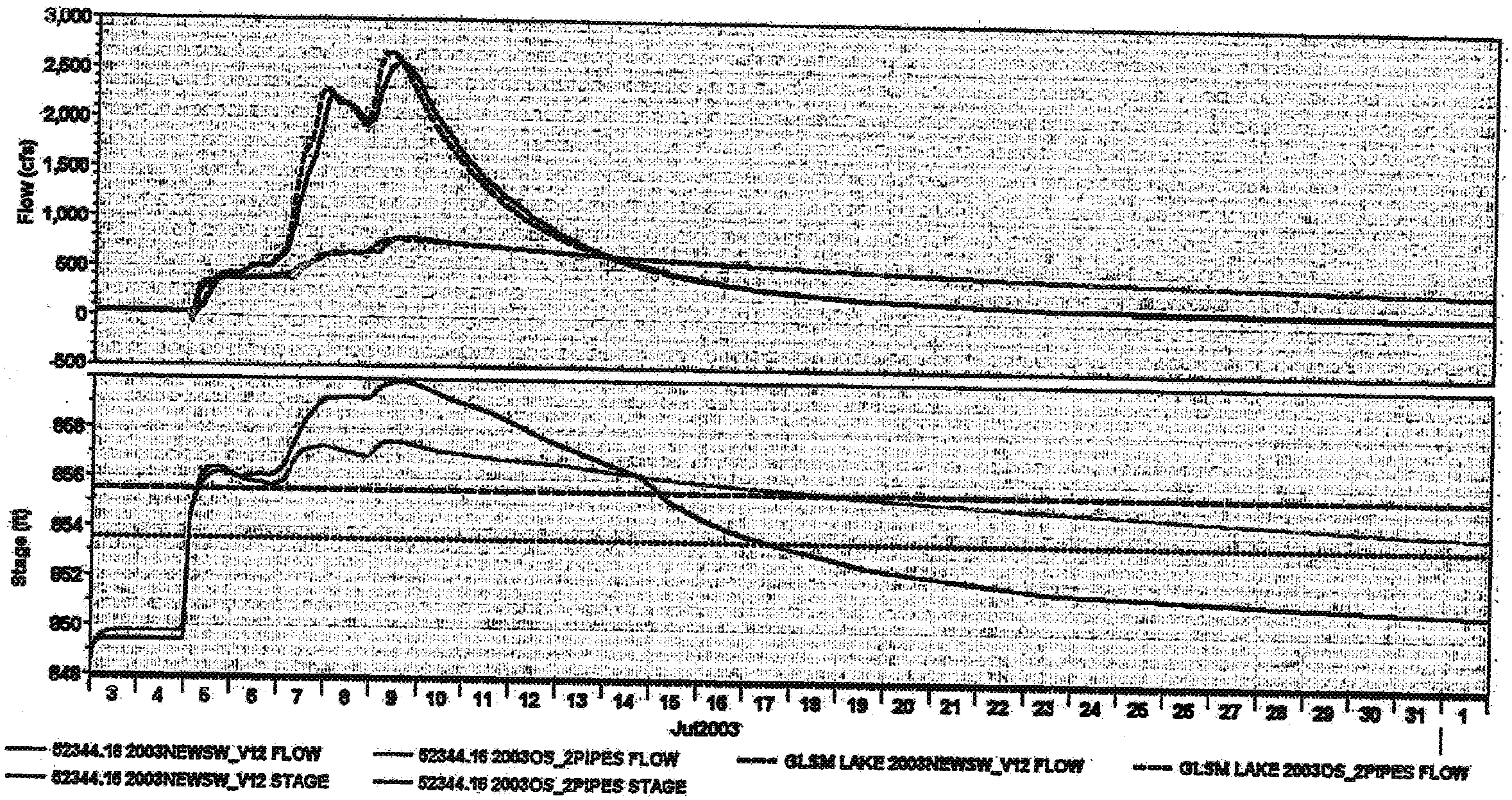

Figure 6: Simulated July 2003 flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on Zumberge parcels 28-022800.0000 (northern) and 28-062900.0000 (middle), both represented by cross section 52344 (blue – new spillway, red – old spillway); black dashed line – northern parcel representative elevation (855.5); black dotted line – middle parcel representative elevation (853.5)

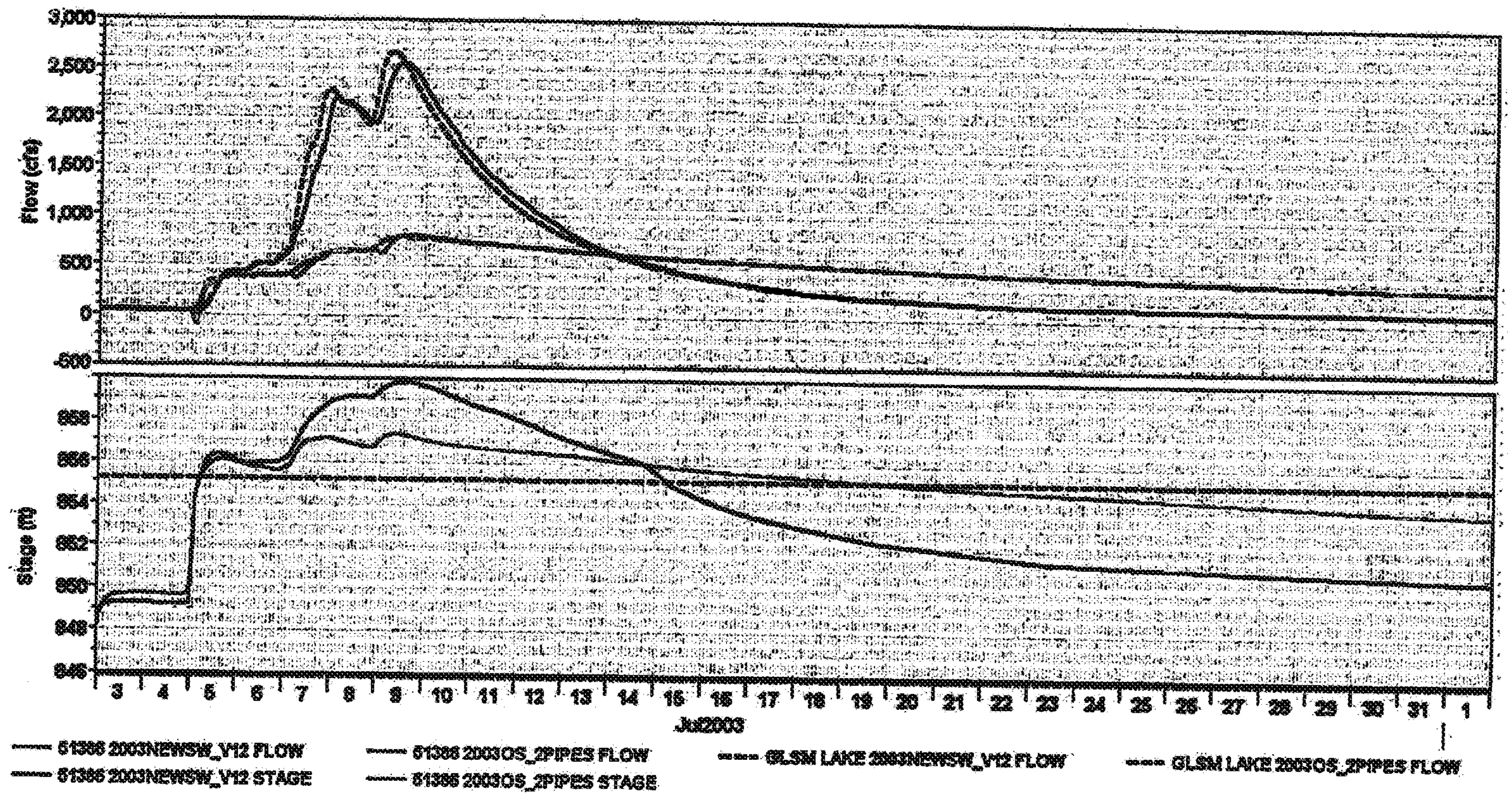

Figure 7: Simulated July 2003 flood GLSM spillway flow (dotted lines in upper graph) and Beaver Creek flow (solid lines in upper graph); Beaver Creek stage (lower graph) on the southern Zimberge parcel, number 28-[illegible], represented by cross section 51386 (blue – new spillway, red – old spillway); black dashed line – parcel representative elevation (855.2)

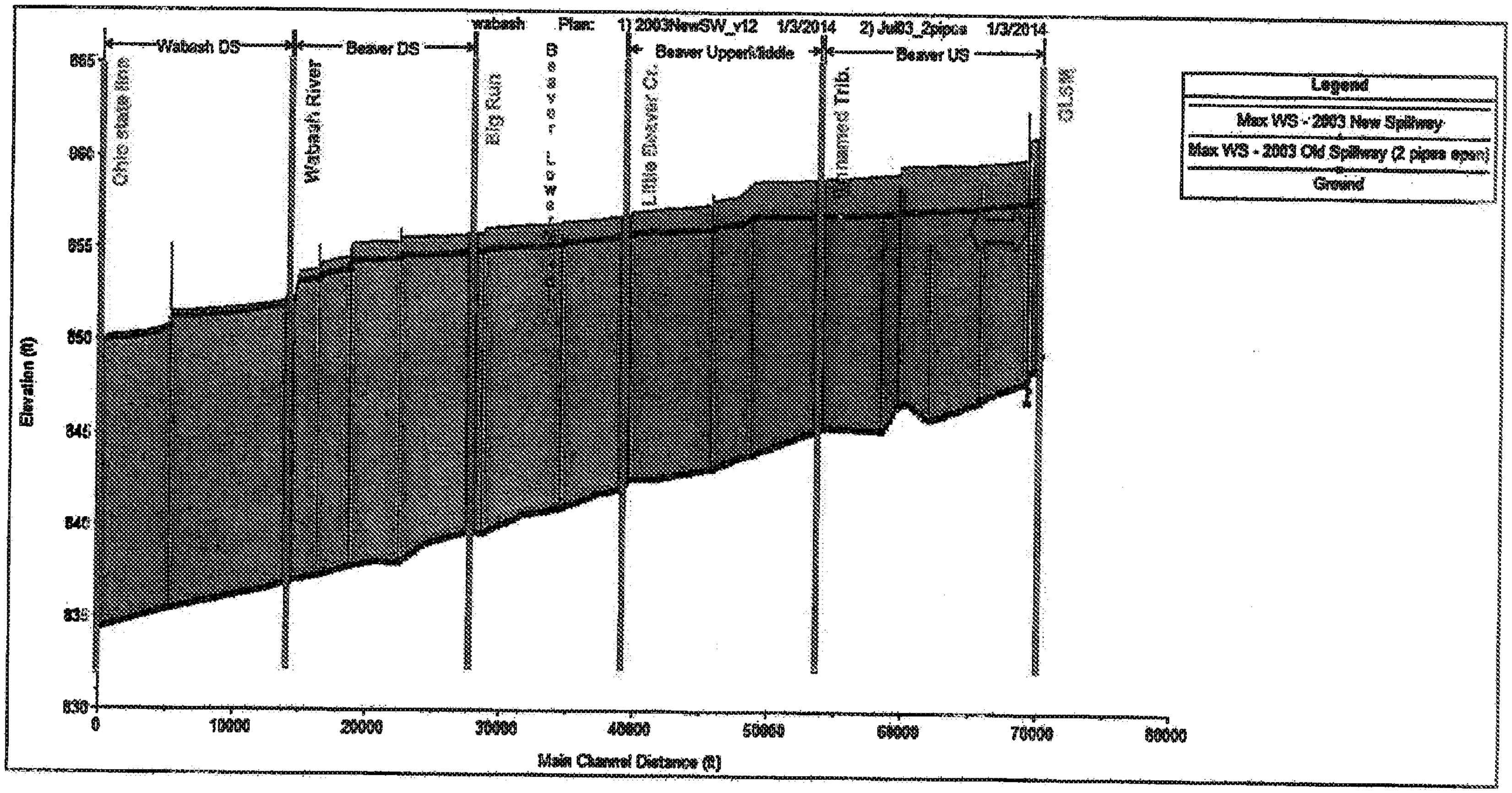
wabash Plan: 1) 2003NewSW_v12 1/3/2014 2) Jul03_2pipes 1/3/2014
Wabash DS
Beaver DS
Beaver Upper/Middle
Beaver US
Ohio state line
Wabash River
Big Run
Little Beaver Cr.
Unnamed Trib.
OLSM
Legend
Max WS - 2003 New Spillway
Max WS - 2003 Old Spillway (2 pipes open)
Ground
Elevation (ft)
Main Channel Distance (ft)
865
860
855
850
845
840
835
830
0
10000
20000
30000
40000
50000
60000
70000
80000

Table 1: Selected flood statistics for Zamberge Parcel Number 26-022600.0000 (northern parcel)

	Flood event	HEC-RAS station	Peak flow(cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 855.5 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 26-022600.0000 (Zamberge, Charles and Jennifer) Parcel reference elevation = 855.5 (Visually selected)	July 2003	51715 51787 52068 52344 52637 53042 53282 53578 53803	810 808 801 787 794 789 788 787 786	2556 2557 2560 2554 2568 2573 2576 2579 2583	1747 1749 1759 1767 1774 1784 1787 1792 1797	857.4 857.4 857.4 857.5 857.5 857.5 857.5 857.5 857.5	859.9 859.9 859.9 859.9 859.9 859.9 859.9 860.0 860.0	2.5 2.5 2.4 2.4 2.4 2.4 2.4 2.5 2.5	10.3	33.6	23.3	13.58	9.88	-3.69

Table 2: Selected flood statistics for Zumberge Parcel Number 28-052900.0000 (middle parcel)

	Flood event	HEC-RAS station	Peak flow(cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 853.5 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 28-052900.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 853.5 (Levee low point)	July 2003	51715	810	2558	1747	857.4	859.9	2.5	61.3	112.6	51.3	28.92	13.54	-15.38
		51787	808	2557	1749	857.4	859.9	2.5						
		52053	801	2560	1759	857.4	859.9	2.4						
		52344	797	2564	1767	857.5	859.9	2.4						
		52637	794	2568	1774	857.5	859.9	2.4						
		53042	789	2573	1784	857.5	859.9	2.4						
		53282	788	2575	1787	857.5	859.9	2.4						
		53578	787	2578	1792	857.5	860.0	2.5						
		53893	786	2583	1797	857.5	860.0	2.5						
		54174	784	2588	1804	857.6	860.0	2.4						
		54434	783	2593	1810	857.6	860.0	2.4						

Table 3: Selected flood statistics for Zumberge Parcel Number 28-051008.0000 (southern parcel)

	Flood event	HEC-RAS station	Peak flow(cfs)			Maximum flood elevation (feet)			Maximum inundated area (acres)			Flood duration > 858.2 (days)		
			Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference	Old spillway	New spillway	Difference
Parcel 28-051008.0000 (Zumberge, Charles and Jennifer) Parcel reference elevation = 858.2 (Visually selected)	July 2003	50861 51142 51386 51548	813 812 810 810	2550 2552 **2555** 2558	1736 1741 1744 1747	857.3 857.3 857.3 857.3	859.8 859.8 859.8 859.8	2.5 2.5 **2.5** 2.5	0.9	22.4	21.6	14.42	10.00	-4.42

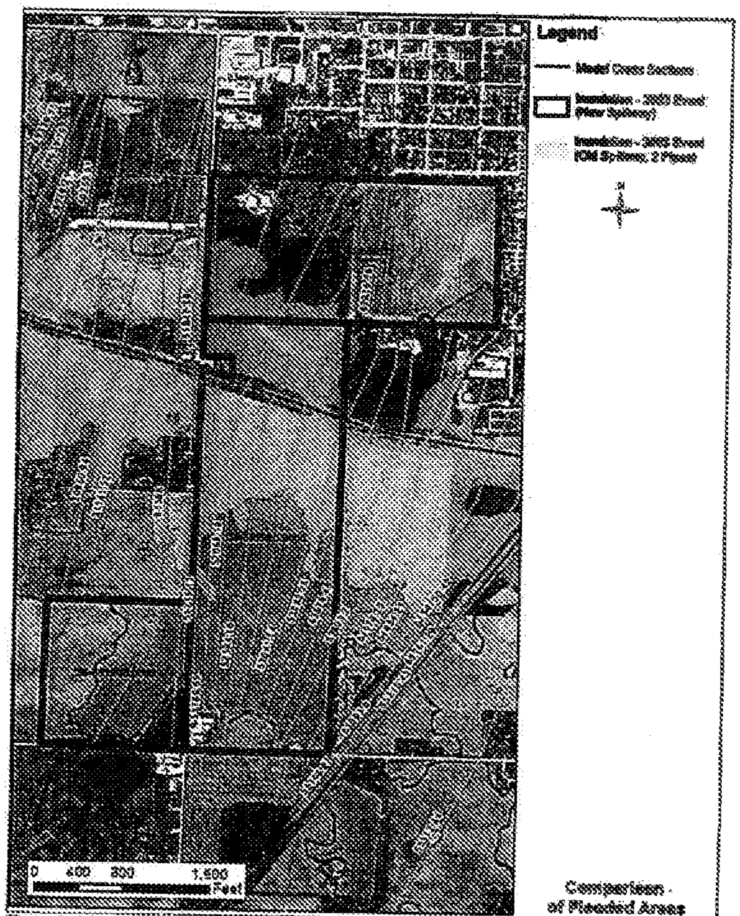

Figure 9: July 2008 flood inundation map, Zumberge parcels, numbers 28-022800.0000 (northern), 28-032800.0000 (middle) and 28-051000.0000 (southern)

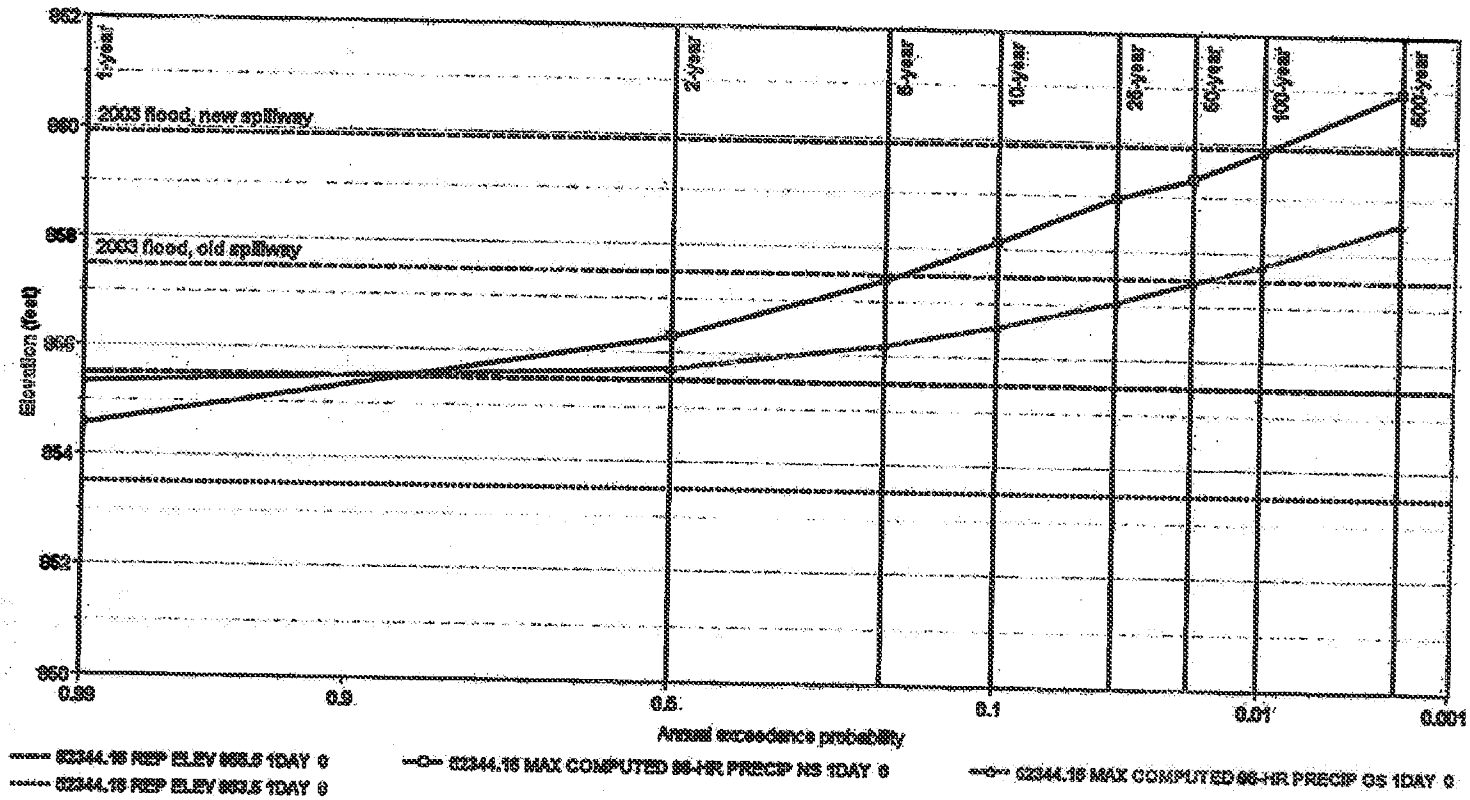

Figure 18: Zumberge northern and middle parcels (28-022800.0000 and 28-052900.0000) flood-frequency data, represented by cross section 52344: Solid blue line with markers – new spillway; solid red line with markers – old spillway; dashed blue line – 2003 peak flood elevation, new spillway; dashed red line – 2003 peak flood elevation, old spillway; dashed black line – parcel 28-022800.0000 representative elevation (855.5); dotted black line – parcel 28-052900.0000 representative elevation (853.5); vertical black lines – estimated return period in years (1 year – 500 years)

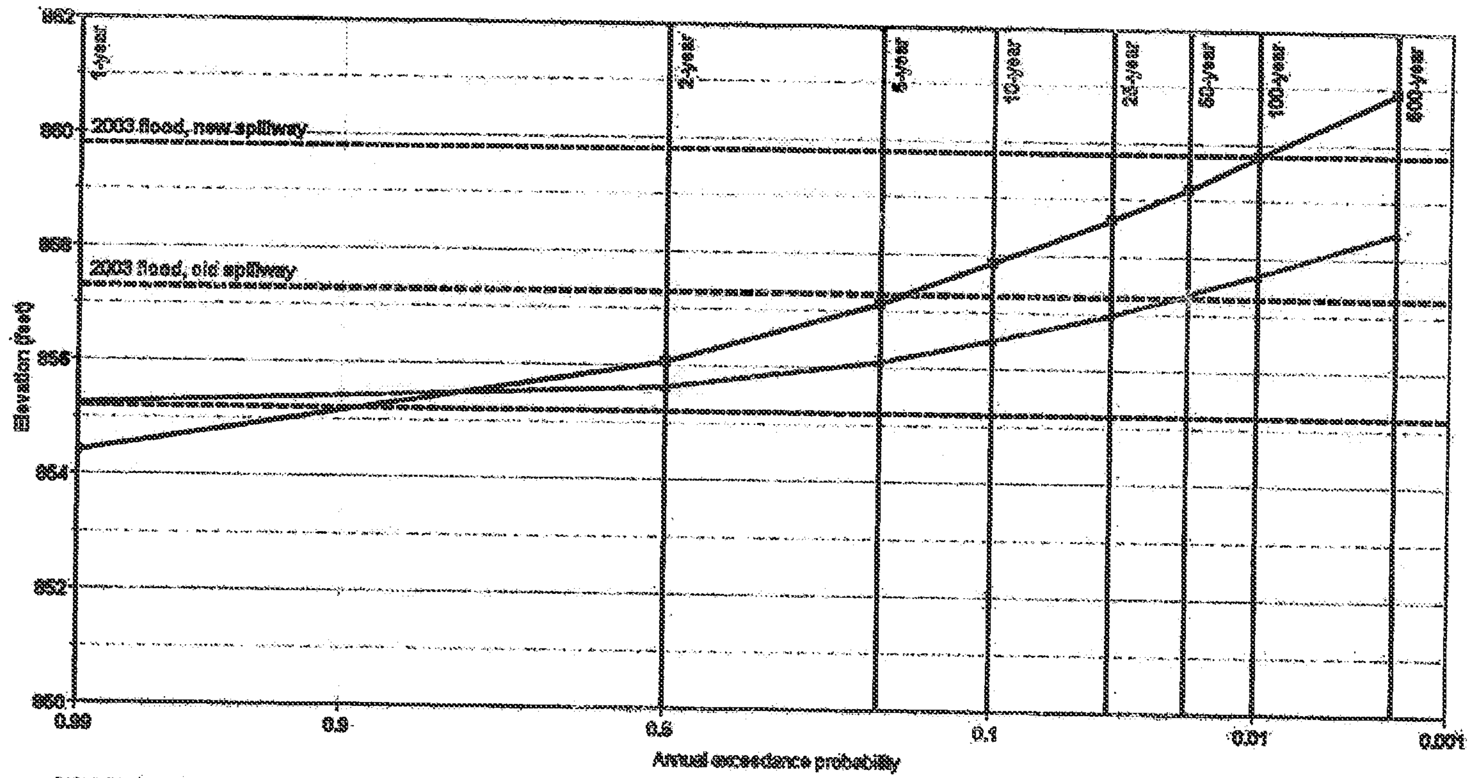

Figure 11: Zamberge southern parcel (26-051000.0000) flood-frequency data, represented by cross section 51386: Solid blue line with markers – new spillway; solid red line with markers – old spillway; dashed blue line – 2003 peak flood elevation, new spillway; dashed red line – 2003 peak flood elevation, old spillway; dashed black line – parcel 26-051000.0000 representative elevation (855.2); vertical black lines – estimated return period in years (1 year – 500 years)

Table 4 - HEC-RAS 2003 flood profile data

River	Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Beaver	US	47549.66	Max WS	2003NewSW_	2541.85	846.11	859.73		859.74	0.000348	0.84	6237.85	3047.87	0.05
Beaver	US	47549.66	Max WS	Jul03_2pipes	744.41	846.11	857.2		857.2	0.000073	0.78	1740.75	1106.67	0.07
Beaver	US	47855.22	Max WS	2003NewSW_	2542.01	845.93	859.74		859.73	0.000026	0.79	7206.1	2256.1	0.05
Beaver	US	47855.22	Max WS	Jul03_2pipes	732.8	845.93	857.22		857.22	0.000028	0.66	2685.05	1389.7	0.04
Beaver	US	47876.47 Footbridge 2		Bridge										
Beaver	US	47903.97	Max WS	2003NewSW_	2542.01	845.93	859.75	852.24	859.75	0.000036	0.79	7797.32	2297.39	0.05
Beaver	US	47903.97	Max WS	Jul03_2pipes	750.79	845.93	857.22	849.08	857.22	0.000018	0.66	2675.55	1390.06	0.05
Beaver	US	48163.5	Max WS	2003NewSW_	2542.14	846	859.75		859.76	0.000019	0.63	8923.13	2584.16	0.04
Beaver	US	48163.5	Max WS	Jul03_2pipes	732.85	846	857.23		857.23	0.000031	0.52	3303.15	1658.75	0.04
Beaver	US	48449.77	Max WS	2003NewSW_	2542.16	846.08	859.76		859.76	0.000015	0.63	8944.15	2784.43	0.04
Beaver	US	48449.77	Max WS	Jul03_2pipes	754.9	846.08	857.23		857.23	0.000015	0.5	3738.8	1859.79	0.03
Beaver	US	48768.59	Max WS	2003NewSW_	2542.54	846.16	859.76		859.77	0.000017	0.62	10149.08	3187.22	0.04
Beaver	US	48768.59	Max WS	Jul03_2pipes	738.76	846.16	857.24		857.24	0.000024	0.6	3123.55	2011.91	0.04
Beaver	US	49076.52	Max WS	2003NewSW_	2542.68	846.24	859.77		859.77	0.000019	0.64	10397.51	3525.83	0.04
Beaver	US	49076.52	Max WS	Jul03_2pipes	760.22	846.24	857.25		857.25	0.000031	0.67	3828.81	2177.08	0.05
Beaver	US	49339.35	Max WS	2003NewSW_	2542.21	846.31	859.77		859.78	0.000016	0.58	10387.22	3370.94	0.04
Beaver	US	49339.35	Max WS	Jul03_2pipes	761.81	846.31	857.25		857.26	0.000031	0.62	3188.89	2468.97	0.05
Beaver	US	49639.79	Max WS	2003NewSW_	2542.55	846.39	859.78		859.78	0.000017	0.52	11375.19	4031.36	0.04
Beaver	US	49639.79	Max WS	Jul03_2pipes	761.68	846.39	857.26		857.26	0.000019	0.55	3415.87	2138.03	0.04
Beaver	US	49978.21	Max WS	2003NewSW_	2542.78	846.48	859.78		859.79	0.000012	0.49	11957.65	3551.54	0.03
Beaver	US	49978.21	Max WS	Jul03_2pipes	763.4	846.48	857.27		857.27	0.000025	0.64	2715.43	2928.84	0.04
Beaver	US	50255.61	Max WS	2003NewSW_	2542.84	846.56	859.79		859.79	0.000012	0.45	12144.9	3541.84	0.03
Beaver	US	50255.61	Max WS	Jul03_2pipes	764.78	846.56	857.28		857.28	0.000036	0.51	3140.8	3025.14	0.04
Beaver	US	50579.91	Max WS	2003NewSW_	2543.5	846.64	859.79		859.8	0.000028	0.68	8779.48	3568.06	0.04
Beaver	US	50579.91	Max WS	Jul03_2pipes	766.07	846.64	857.28		857.29	0.000036	0.72	2117.08	1026.63	0.05
Beaver	US	50860.64	Max WS	2003NewSW_	2543.83	846.72	859.8		859.8	0.000020	0.7	8760.51	3560.88	0.03
Beaver	US	50860.64	Max WS	Jul03_2pipes	766.12	846.72	857.25		857.3	0.000049	0.61	2703.1	1358.55	0.05
Beaver	US	51141.32	Max WS	2003NewSW_	2543.82	846.79	859.81		859.81	0.000026	0.78	8837.04	3379.59	0.05
Beaver	US	51141.32	Max WS	Jul03_2pipes	768.3	846.79	857.31		857.32	0.00006	0.91	3572.55	1242	0.07
Beaver	US	51506	Max WS	2003NewSW_	2544.87	846.86	859.82		859.82	0.000035	0.84	9429.67	4750.4	0.05
Beaver	US	51506	Max WS	Jul03_2pipes	768.47	846.86	857.32		857.35	0.000139	1.48	828	708.04	0.1
Beaver	US	51547.38	Max WS	2003NewSW_	2545.06	846.9	859.82		859.82	0.000018	0.59	12234.09	4696.67	0.04
Beaver	US	51547.38	Max WS	Jul03_2pipes	769.39	846.9	857.33		857.38	0.000184	1.75	489.74	62.93	0.12
Beaver	US	51634.92 Meyer Rd.		Bridge										
Beaver	US	51715.13	Max WS	2003NewSW_	2545.72	847.1	859.87	853.36	859.87	0.000015	0.56	12463.93	4718.39	0.03
Beaver	US	51715.13	Max WS	Jul03_2pipes	773.34	847.1	857.39	850.33	857.45	0.000187	1.75	503.73	1524.83	0.12
Beaver	US	51786.99	Max WS	2003NewSW_	2545.8	847.12	859.87		859.87	0.000019	0.55	11751.59	4616.09	0.04
Beaver	US	51786.99	Max WS	Jul03_2pipes	774.82	847.12	857.4		857.46	0.000184	1.73	535.96	1549.92	0.12
Beaver	US	52068.18	Max WS	2003NewSW_	2546.06	847.2	859.87		859.88	0.000021	0.6	10832.98	4319.86	0.04
Beaver	US	52068.18	Max WS	Jul03_2pipes	775.36	847.2	857.42		857.48	0.000141	1.32	591.91	1117.62	0.1
Beaver	US	52344.16	Max WS	2003NewSW_	2546.31	847.28	859.88		859.88	0.000022	0.63	7928.02	4357.84	0.04
Beaver	US	52344.16	Max WS	Jul03_2pipes	777.02	847.28	857.45		857.47	0.00009	1.17	1419.15	969.96	0.08
Beaver	US	52636.76	Max WS	2003NewSW_	2546.52	847.36	859.89		859.89	0.000029	0.76	6931.41	4293.38	0.05
Beaver	US	52636.76	Max WS	Jul03_2pipes	778.35	847.36	857.47		857.5	0.000118	1.31	1126.03	788.04	0.09
Beaver	US	53041.74	Max WS	2003NewSW_	2547.81	847.47	859.9		859.91	0.000054	1.17	4052.31	3185.02	0.07
Beaver	US	53041.74	Max WS	Jul03_2pipes	778.86	847.47	857.49		857.49	0.000043	0.81	1881.33	1163.57	0.06
Beaver	US	53282.25	Max WS	2003NewSW_	2549.11	847.54	859.92		859.93	0.000104	1.48	3106.59	2906.13	0.09
Beaver	US	53282.25	Max WS	Jul03_2pipes	779.88	847.54	857.5		857.51	0.000065	1	1487.4	941.25	0.07
Beaver	US	53578.45	Max WS	2003NewSW_	2547.88	847.62	859.95		859.96	0.000105	1.49	2970.83	3066.29	0.08

River	Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Beaver	US	53578.45	Max WS	Jul03_2pipes	779.27	847.62	857.52		857.53	0.000062	0.55	1538.99	1211.63	0.07
Beaver	US	53803.2	Max WS	2003NewSW_	2549.32	847.68	859.97		859.98	0.000071	1.21	3944.9	4399.12	0.08
Beaver	US	53803.2	Max WS	Jul03_2pipes	779.51	847.68	857.53		857.54	0.000064	0.91	1472.91	1516.2	0.07
Beaver	US	54174.35	Max WS	2003NewSW_	2553.48	847.78	860		860.01	0.000093	1.43	3133.38	3636.86	0.09
Beaver	US	54174.35	Max WS	Jul03_2pipes	779.58	847.78	857.55		857.56	0.000049	0.89	1456.97	1463.18	0.06
Beaver	US	54434.21	Max WS	2003NewSW_	2555.73	847.86	860.02		860.05	0.00016	1.62	2080.69	2947.82	0.11
Beaver	US	54434.21	Max WS	Jul03_2pipes	780.01	847.86	857.57		857.58	0.0001	0.94	1062.08	1508.25	0.08
Beaver	US	54750.42	Max WS	2003NewSW_	2557.34	847.94	860.06		860.11	0.000197	1.87	1789.71	2845.58	0.13
Beaver	US	54750.42	Max WS	Jul03_2pipes	779.85	847.94	857.6		857.62	0.000114	1.06	914.98	1247.96	0.09
Beaver	US	55093.8	Max WS	2003NewSW_	2582.68	848.04	860.14		860.33	0.000948	3.46	742.62	1829.88	0.26
Beaver	US	55093.8	Max WS	Jul03_2pipes	780.04	848.04	857.64		857.68	0.000266	1.71	456.12	91.21	0.13
Beaver	US	55117.88 Railroad		Bridge										
Beaver	US	55146.27	Max WS	2003NewSW_	2587.73	848.09	860.3	854.01	860.64	0.00068	3.11	293.19	1953.14	0.22
Beaver	US	55146.27	Max WS	Jul03_2pipes	779.83	848.09	857.69	851.02	857.73	0.000228	1.83	477.47	91.96	0.13
Beaver	US	55161.29	Max WS	2003NewSW_	2589.05	846.98	860.38		860.39	0.000071	1.04	5158.48	1989.39	0.07
Beaver	US	55161.29	Max WS	Jul03_2pipes	780.04	846.98	857.7		857.73	0.000169	1.48	525.38	91.86	0.11
Beaver	US	55179.88 Old RR - Bike pa		Bridge										
Beaver	US	55215.45	Max WS	2003NewSW_	2599.41	846.98	861.22	853.39	861.22	0.000082	0.5	7858.87	8026.06	0.05
Beaver	US	55215.45	Max WS	Jul03_2pipes	779.83	846.98	857.72	850.31	857.77	0.000242	1.72	454.38	220.81	0.15
Beaver	US	55312.84	Max WS	2003NewSW_	2598.31	847.89	861.23		861.23	0.000008	0.4	15884.02	8659.37	0.03
Beaver	US	55312.84	Max WS	Jul03_2pipes	780.09	847.89	857.77		857.73	0.000113	1.06	817.46	724.3	0.09
Beaver	US	55428.93	Max WS	2003NewSW_	2600.54	848.34	861.23		861.23	0.000013	0.38	12790.4	5037.37	0.03
Beaver	US	55428.93	Max WS	Jul03_2pipes	779.85	848.34	857.78		857.8	0.000148	1.35	302.55	880.06	0.1
Beaver	US	55461.52 US 127		Bridge										
Beaver	US	55535.65	Max WS	2003NewSW_	2801.7	848.56	861.28	854.45	861.29	0.000018	0.53	13023.93	3038.54	0.03
Beaver	US	55535.65	Max WS	Jul03_2pipes	780.06	848.56	857.81	851.94	857.84	0.000324	1.57	513.08	862.94	0.12
Beaver	US	55670.68	Max WS	2003NewSW_	2602.07	848.75	861.29		861.29	0.000008	0.38	18980.85	6589.58	0.02
Beaver	US	55670.68	Max WS	Jul03_2pipes	779.94	848.75	857.85		857.86	0.000113	1.08	858.76	1149.8	0.09
Beaver	US	55848.93	Max WS	2003NewSW_	2600.8	849	861.29		861.39	0.000019	0.53	8860.06	2454.41	0.04
Beaver	US	55848.93	Max WS	Jul03_2pipes	780.09	849	857.87		857.91	0.000284	1.35	502.49	112.35	0.13
Beaver	US	56213.97	Max WS	2003NewSW_	2606.22	849.3	861.33		861.52	0.0005	3.34	785.76	98.28	0.2
Beaver	US	56213.97	Max WS	Jul03_2pipes	780.1	849.3	857.95		858	0.000218	1.63	473.06	86.02	0.12
Big Run	Big Run	334.2123	Max WS	2003NewSW_	389.65	839.72	855.81		855.81	0.000004	0.27	2040.92	782.81	0.02
Big Run	Big Run	334.2123	Max WS	Jul03_2pipes	605.73	839.72	854.78		854.78	0.000018	0.51	1721.74	777.14	0.03
Big Run	Big Run	494.3325	Max WS	2003NewSW_	389.78	840.96	855.81		855.81	0.000005	0.33	1672.56	832.73	0.02
Big Run	Big Run	494.3325	Max WS	Jul03_2pipes	803.62	840.96	854.78		854.79	0.000032	0.63	1403.52	832.73	0.04
Big Run	Big Run	675.2391	Max WS	2003NewSW_	389.84	841.89	855.81		855.81	0.00002	0.64	707.79	633.52	0.04
Big Run	Big Run	675.2391	Max WS	Jul03_2pipes	803.84	841.89	854.78		854.8	0.000078	1.15	817.03	589.14	0.07
Big Run	Big Run	720.1556 29		Bridge										
Big Run	Big Run	779.9132	Max WS	2003NewSW_	493.19	841.91	855.83	846.53	855.84	0.00002	0.64	907.27	654.78	0.04
Big Run	Big Run	779.9132	Max WS	Jul03_2pipes	617.03	841.91	854.85	847.02	854.87	0.000057	1.02	785.05	591.65	0.06
Big Run	Big Run	915.2225	Max WS	2003NewSW_	488.38	842.15	855.84		855.84	0.000012	0.46	1719.52	447.61	0.03
Big Run	Big Run	915.2225	Max WS	Jul03_2pipes	617.08	842.15	854.87		854.87	0.000041	0.79	1322.58	403.98	0.05
Big Run	Big Run	1128.989	Max WS	2003NewSW_	488.32	842.54	855.84		855.84	0.000012	0.45	1754.07	456.72	0.03
Big Run	Big Run	1128.989	Max WS	Jul03_2pipes	620.74	842.54	854.88		854.88	0.000041	0.78	1384.1	420.59	0.05
Big Run	Big Run	1334.896	Max WS	2003NewSW_	479.15	842.91	855.84		855.85	0.000011	0.45	2184.4	654.33	0.03
Big Run	Big Run	1334.896	Max WS	Jul03_2pipes	620.78	842.91	854.88		854.88	0.000038	0.75	1611.3	568.11	0.05
Big Run	Big Run	1504.382	Max WS	2003NewSW_	478.27	843.21	855.84		855.85	0.000016	0.49	1720.26	802.17	0.03