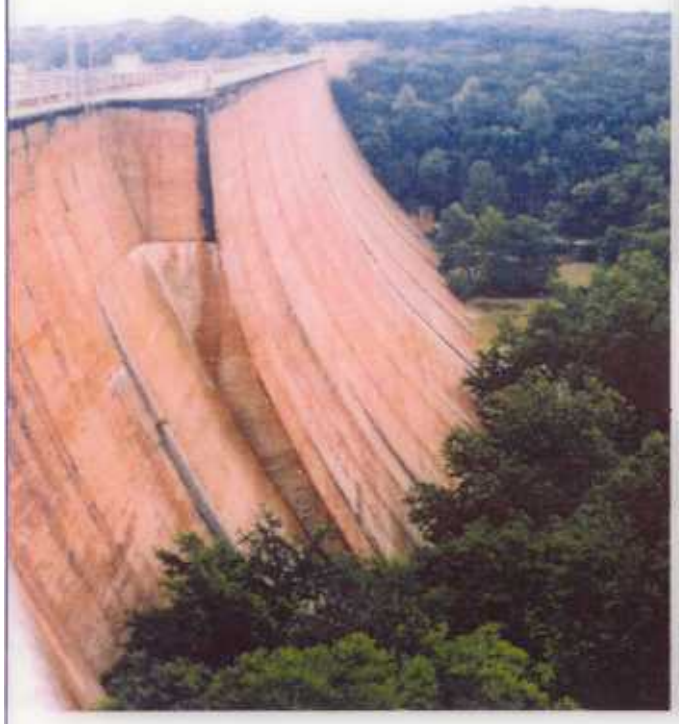
Lake Medina Dam

Dam Safety Inspection Report

Site Inspections on July 5 and July 6, 2002
for the
Texas Natural Resource Conservation Commission

2002



Freese and Nichols, Inc.
Consulting Engineers
Austin, Texas

Lake Medina Dam

Dam Safety Inspection Report
for Site Inspections on July 5 and July 6, 2002
for the
Texas Natural Resource Conservation Commission

Freese and Nichols, Inc.
Consulting Engineers
Austin, Texas

TABLE OF CONTENTS

1.0 INTRODUCTION

This report documents the observations, findings, and recommendations made by Freese and Nichols (FNI) in conjunction with its inspection of Lake Medina Dam on July 5 and July 6, 2002. The Medina River watershed was undergoing extreme flooding caused by a tropical storm, which had stalled over the watershed for the previous week. Lake Medina experienced three flood peaks. The last peak reached an historic level. During the second peak of the flood, the Texas Natural Resource Conservation Commission (TNRCC) was asked by Federal Emergency Management Agency (FEMA) and by the State's Department of Emergency Management (DEM) to assess the integrity of the dam and to make recommendations concerning public evacuations below the dam along the Medina River. In turn, on Friday morning, July 5, the TNRCC requested FNI's assistance in its evaluation of the dam safety situation at the dam.

2.0 SITE VISIT ON FRIDAY, JULY 5, 2002

John King, P.E. (FNI, Austin) and Murphy Parks, E.I.T. (FNI, Austin) met Chau Vo, P.E. (TNRCC Dam Safety Coordinator, Austin) at the Lake Medina Dam's left abutment at roughly 1 pm. The dam's abutment is in the town of Mico. The main road through the town was blocked with barricades at the abutment. There was a steady stream of onlookers along the security fence overlooking the dam.

When FNI initially arrived at the left abutment, the access gate was locked. **(Photo 1)** The Bexar-Medina-Attascosa Irrigation District's (BMA) dam tender was on the crest of the dam with a San Antonio news media cameraman (Channel 12). FNI saw no other signs of the news media at or on the dam. The inspection team was able to get a Medina County sheriff deputy, who was patrolling the area, to alert the BMA dam tender to provide access onto the dam. The BMA dam tender (Wayne Solzman) was briefed on the purpose of the inspection (i.e. to perform a dam safety inspection of sufficient degree to determine whether or not there needed to be dam-safety related evacuations below the dam). The Deputy and Mr. Solzman informed us that:

- Castroville residents had already been evacuated the previous evening (i.e. Thursday) because of flooding along the Medina River,
- the U.S. Army Corp of Engineers (COE) and FEMA representatives had already inspected the dam that morning, at about 10 am, and had told them that there was no problem with the dam, and
- the lake was now rising at about 5 inches per hour.

Mr. Solzman provided access onto the dam, but did not accompany the inspection team on the inspection of the concrete gravity section proper. He accompanied the team on the inspection of the right abutment of the dam and of the emergency

spillway. There were no engineering reports or construction drawings available on site.

2. GENERAL CONDITIONS

During the July 5 site inspection the weather was overcast, with scattered showers. We had traveled through heavy rainfall between San Antonio and the dam. The heavy rain tapered off by the time we accessed the dam (approximately 1:30 pm). There was no appreciable wind.

We did not have absolute reservoir level information; however, the BMA was recording stage height over some arbitrary zero datum, perhaps the emergency spillway crest level. The staff gage was a vertical steel stand pipe with graduations in feet, and was located about 20 feet upstream of the right abutment's concrete gravity section, within the drawdown of the emergency spillway flows. Mr. Solzman told us that during the COE inspection, the reservoir was at a stage of about 4 feet. During our inspection it was at a stage of about 6.5 feet, but was rising at a rate of 5 inches per hour (per Mr. Solzman). **(Photo 2)** It appeared to us that the reservoir was about 5 feet below the top of the crest of the concrete gravity section of the dam. By the end of our inspection, Mr. Solzman informed us that the reservoir had risen almost 2 feet while we were on site.

While we were in route to the dam, an FNI staff member checked the local weather forecast, via the Internet. The forecast was continued rainfall for the next 5 days, anticipating up to 6 inches of additional rainfall.

OBSERVATIONS

Our "route" for observations started at the left abutment, proceeding along the crest of concrete gravity sections, and ending at the right abutment and emergency spillway. We did not access the downstream toes of the concrete gravity sections. We observed the following:

Concrete Gravity Section - Left Abutment

There were not signs of foundation seepage or foundation leakage along the toe and abutment of the left abutment's concrete gravity section. In spite of the recent heavy rains, there were minimal signs of soil erosion. It appeared that fill had been imported to level a portion of the abutment area, immediately adjacent to the gravity section. There were no signs of movement or seepage within the fill; however, we could not observe the conditions of the underlying natural foundation formations.

There were no visible signs of distress along the exposed surfaces of the gravity section's crest and downstream face. Past thermal expansion/contraction vertical cracking within the concrete appeared to extend the full height and width of the

structure, spaced about 10 feet ± apart. None of the vertical cracks exhibited differential structural movement (i.e. there were no visible offsets across the cracks, no spalling along the cracks, and no growth of the cracks). We also did not observe any new cracks. Two (2) cracks were discharging seepage apparently from the reservoir. The cracks had dark stains where it appeared they had discharged in the past. **(Photo 3)** Mr. Solzman later informed us that the discharges through the cracks were a normal occurrence. We observed that the cracks were discharging at about 3 to 4 feet higher up within the crack than the concrete discoloration. The flows through the cracks were clear. We saw no signs of leakage through the horizontal construction joints.

2.2.2 Concrete Gravity Section - River

Mr. Solzman later informed us that this section of the dam, which was the tallest section, had a maximum height of about 180 feet. There was minimal tailwater against the toe of the dam. **(Photo 4)** It appeared that the tailwater level was about two (2) feet below the sill of the inspection gallery access portal at the base of the dam. Because of the tailwater inundation, we were not able to see the condition of the foundation rock. We saw no signs of foundation movements or upheavals above tailwater level. From our vantage point, 180 feet above the riverbed, we observed no visible upswells or bubbles rising up through the tailwater along the toe (base) of the dam. The tips of several PVC standpipes were visible above the tailwater.

The condition of the mass concrete was much the same as for the concrete gravity section along the left abutment. There were no signs of new cracking, no signs of movements, and no signs of spalling. There were numerous cracks discharging similarly to the cracks we observed in the left abutment section. Two (2) cracks were discharging silt-laden flows. We saw no signs of leakage through the horizontal construction joints. **(Photos 5 and 6)**

2.2.3 Outlet Works

Two (2) of the three (3) outlet works were discharging. We do not know the rate of discharge. Mr. Solzman later informed us that the valve on the third (left-most) outlet pipe was not operational. We observed considerable leakage coming out of the side of the valve housing of the right-most outlet. **(Photo 7)** Mr. Vo (TNRCC) informed us that he was currently reviewing BMA engineering plans to rehabilitate the outlet works. From our vantage point, 180 feet above the riverbed and outlet works, we saw no signs of distress in the valves that would have indicated pending valve failure. We were not able to observe the condition of the concrete flume below the valves or the river channel immediately below the flume's termination because of the turbulence and depth of the outlet works' discharge.

2.2.4 Concrete Gravity Section - Right Abutment

The heavy overgrowth along the immediate toe of the dam made it difficult to observe the foundation and seepage conditions along the right abutment section. We were able to observe that there was a much greater (visible) accumulated flow along the toe (base) of the dam along this section, as compared to the accumulated flow along the left abutment section. **(Photo 8)** We also observed a concentrated discharge coming from an exposed rock formation about 10 feet downstream of the toe of the dam, near the junction of the right abutment section with the river section. **(Photo 9)** From our vantage point on the crest, the concentrated discharge appeared to be clear. There were no signs of accumulated flows of this magnitude above this rock outcropping, and the magnitude of the discharges from the vertical cracks above the outcropping did not account for the rate of discharge from the outcropping. There were no visible signs of foundation movements around the discharge area (however, the heavy undergrowth and trees obstructed the view of practically all of the foundation area below the dam).

In general, the visible condition of the right abutment's concrete gravity section was the same as the condition of the left abutment's concrete gravity section. There were no signs of new cracking, no signs of movements, and no signs of spalling. One (1) vertical crack near the junction of the right abutment section with the river section (almost in line with the concentrated discharge from the rock outcropping) was a much more "jagged" crack than any of the other observed cracks, and was discharging at much higher rates (between 50 to 100 gpm). **(Photos 10 and 11)**

Mr. Solzman joined us when we reached the right end of the right abutment's concrete gravity section.

There was active erosion occurring along the immediate right end of the right abutment. **(Photo 12)** It appeared that the left bank and the crest of the emergency spillway channel were very close to the end of the right abutment gravity section. In order for flows to enter the emergency spillway channel, the flow direction had to take almost a 90^{o} turn to the right. The "outside bend" of the current was sweeping along the upstream face of the end of the right gravity section, and then accelerating to supercritical flow at the "lip" of the control section behind the end of the gravity section. **(Photo 13)** There were standing waves along the upstream face of the gravity section and along the periphery of the flows behind the end of the gravity section. **(Photo 14)** The accelerating flows and standing waves were actively eroding the fill encapsulating the end of the gravity section. Mr. Solzman informed us that the BMA had recently constructed an access road around the end of the dam to provide access into and across the emergency spillway channel. It appeared to Mr. Solzman that the erosion was occurring within this access road fill. There was less than a 50-feet wide area of this actively eroding fill preventing the accelerated emergency spillway flows from flanking the right abutment of the dam.

In addition to the erosion at the immediate end of the gravity section, the emergency spillway flows were overtopping its left overbank, beginning at the end of the gravity section, and overland flows were fanning out behind and downstream from the right end of the dam. **(Photo 15)** The "lip" of the emergency spillway channel was about 150 to 200 feet at its closest point downstream and behind the right end of the concrete gravity section. **(Photos 13 and 14)**

Our observations of the emergency spillway are documented in the next section.

2.2.5 Emergency Spillway

We did not have engineering drawings of the layout of the emergency spillway channel, especially with respect to its alignment at the right end of the right abutment's concrete gravity section. We observed an extreme amount of turbulence and standing waves within the channel, especially as the flows were accelerating toward the "lip" of the emergency spillway. **(Photos 16 and 17)** The control section of the spillway appeared to be the lip where flows plunged some 30 to 40 feet over the downstream edge of the channel floor, cascaded over the rock formations, and were collected in a side channel. Mr. Solzman informed us that the emergency spillway was unlined, having been excavated through "solid rock". We did not observe any active erosion or scour within the emergency spillway channel, nor observe the "lip" to progress upstream into the reservoir. However, the extreme turbulence and depth of flow made any such observations difficult. A colleague in our Austin office later informed us that the spillway channel width was about 1500 feet, straight across from one bank (i.e. the right end of the right abutment's concrete gravity section) to the other. However, the control section's lip was in a concave alignment, with its apex in the upstream direction. **(Photos 16 and 18)** We were not able to detect if the apex was moving upstream, but the apex was concentrating flows into almost a "V" configuration into the rock. We also were not able to determine if the previous days' discharges through the emergency spillway had caused the apex of the lip to move upstream. Mr. Solzman informed us that before this flood, the lip did have such a configuration, but he did not know if the alignment we observed was different from the past alignment.

We were able to access the left overbank of the side channel, about 100 to 200 feet downstream of the lip of the emergency spillway. The flow condition was extremely turbulent and was supercritical. There appeared to be active erosion and scour along the right (opposite) bank. **(Photos 19 and 20)**

We were not able to access the discharge end of the emergency spillway's side channel to determine if there was a rock debris field within the Medina River channel.

2.3 ASSESSMENT OF CONDITIONS OBSERVED ON JULY 5

Based upon our on-site observations on July 5 and the limited information that was made available to us, we reached the following conclusions:

1 The concrete gravity sections of the dam appeared to be stable, with no active signs of structural movements or distress.

2. The exposed foundation along the downstream toe of the left abutment and the river section of the concrete gravity sections appeared to be stable, with no signs of movements or excessive seepage.

3. The concentrated seepage discharges from the rock outcropping adjacent to the most significant vertical crack in the right abutment's concrete gravity section indicated a pressurized foundation zone, with an uplift that might be approaching straight-line uplift.

4. The erosion around the immediate right end of the right abutment's concrete gravity section posed a high risk of breaching the right abutment, if the erosion remained unchecked. A release of floodwaters through the breach section along the downstream toe of the right abutment, could then very likely initiate a failure in the right abutment's concrete gravity section.

5. Under the projected condition of a rapidly rising reservoir (i.e. at 5 inches per hour) and the projected rainfall forecast of up to 6 inches within the following five (5) days, all concrete gravity sections and abutments were in danger of overtopping. Since there was minimal tailwater along the toe of the river section of the concrete gravity section, and no tailwater along the abutment sections, an overtopping flow could very likely erode the foundation along the toe of the dam, passive resistance against sliding would be lost, and failure of gravity sections would most likely be initiated. Failure of the 180-feet high river section would be catastrophic.

6. Though we did not observe active erosion and scour of the "lip" of the emergency spillway, monitoring of the hydraulic conditions was warranted, especially where the lip was within 150 to 200 feet of the end of the right abutment's concrete gravity section.

7. Our overall conclusion was that the integrity of the dam could not be assured.

2.4 RECOMMENDATIONS ON JULY 5

Based upon our observations, conclusions, and the projected weather forecast we initially recommended to Mr. Vo (TNRCC) at 5 pm and then to the state and federal disaster response officials via telephone conference at 7 pm that:

1 appropriate evacuations be made below Lake Medina Dam, along the Medina River floodway,

2. a failure of Lake Medina Dam could release at least 500,000 cfs almost instantaneously (based upon FNI's experience with breach analyses of a similar gravity dam on the Colorado River), and

3. the services of the National Weather Service be engaged to assist in forecasting the velocity of the breach wave and its peak stages downstream of the dam.

The COE representative participating in the 7 pm telephone conference agreed with our recommendations.

Upon the conclusion of the 7 pm telephone conference, State emergency response officials (DEM) immediately initiated the communications process with local governmental officials concerning the need and urgency for evacuations below Lake Medina Dam.

We also reported our observations and preliminary conclusions to Mr. Solzman (BMA) at the conclusion of our site visit, at about 4 pm. We did not know if Mr. Solzman relayed this information on to BMA management.

3.0 SITE VISIT ON SATURDAY, JULY 6, 2002

Mr. King and Mr. Parks (both with FNI) once again accompanied Mr. Vo (TNRCC) to the site on Saturday morning. The purpose of the second visit was to allow a joint inspection, with FEMA, COE, DEM, TNRCC, FNI, and BMA's Vice President of the Board in attendance. The hydraulic conditions at the right end of the dam, in the emergency spillway, as observed by the COE Friday morning had been different (and less severe) than the hydraulic conditions observed by FNI Friday afternoon. The inspection gave all parties the opportunity to jointly observe the same conditions.

3.1 GENERAL CONDITIONS

During the July 6 site inspection, the weather was partly cloudy, with no rain and no appreciable wind. We were informed that during the night, the reservoir had peaked at an historic stage within 18 to 20 inches of the top of the dam. By the

time we reached the dam, at about 9 am, the reservoir had already dropped to a stage of 4.5 feet, some 2 feet below the reservoir level when we were on site the previous day, but near the same level when the COE was on site earlier than us on Friday morning. **(Photo 21)** Therefore, the hydraulic conditions we jointly observed on Saturday morning were very similar to the hydraulic conditions observed by the COE on Friday morning.

OBSERVATIONS

We followed the same "route" along the dam as we followed the previous day, except we also accessed the downstream toe of the right abutment's concrete gravity section to specifically observe the concentrated seepage exiting the rock outcropping. We observed the following:

Concrete Gravity Section - Left Abutment

The conditions we observed on the previous day were relatively unchanged, with the following exceptions:

The seepage rate through the two vertical cracks had diminished, and the tops of the exit points within the cracks had dropped by several feet.

2. We observed a damp section along the downstream face of this section that we felt was evidence that a continuous line of seepage had exited along roughly a 100-feet long section of the highest horizontal construction joint. **(Photo 22)** We did not observe this seepage on Friday or on Saturday, so we assumed the seepage appeared in conjunction with the reservoir peak during the night and disappeared as the reservoir level receded before we were on site on Saturday.

Concrete Gravity Section - River

The conditions we observed on the previous day were relatively unchanged, with the following exceptions:

The seepage rates through the vertical cracks had diminished, and the tops of the exit points within the cracks had dropped by several feet.

2. We observed a damp section along the downstream face of this section that we felt was evidence that a continuous line of seepage had exited along roughly a 200-feet long section of the highest horizontal construction joint. **(Photo 23)** We did not observe this seepage on Friday or on Saturday, so we assumed the seepage appeared in conjunction with the reservoir peak during the night and disappeared as the reservoir receded before we were on site on Saturday.

3. The tailwater level was several feet higher than we observed on Friday. From our vantage point on the crest, it appeared that the tailwater level was only several feet up on the bulkhead door for the inspection gallery. **(Photo 24)**

Outlet Works

The conditions we observed on the previous day were relatively unchanged.

3.2.4 Concrete Gravity Section - Right Abutment

The conditions we observed on the previous day were relatively unchanged, with the following exceptions:

1 The seepage rate through the vertical crack had diminished, and the top of the exit point within the crack had dropped by several feet.

2. The seepage rate from the rock outcropping may have slightly diminished.

3. In accessing several areas of the abutment, along the toe of the dam, we also noticed another seepage discharge from the rock outcropping near the first seepage area. Because of the heavy undergrowth, we could not determine if this second seepage area was existing or new. **(Photos 25 and 26)**

4. With the reservoir level having receded to about the same level as when the COE performed its Friday morning inspection, the hydraulic conditions were not as severe as what we observed Friday afternoon, nor as severe as apparently occurred during the night when the reservoir level peaked. The flow depth through the emergency spillway had dropped low enough prior to the Saturday inspection that the flows were within the confines of the emergency spillway channel and erosion around the end of the gravity section had stopped. **(Photo 27)**

5. The fill around the right end of the gravity section had eroded some 10 feet into the overbank, exposing at least five (5) feet of the end of the structure. The fill had eroded down to the top of the rock formation, which was about 5 to 7 feet below the crest of the dam. **(Photo 27)**

Emergency Spillway

Even though the reservoir level had receded since the Friday afternoon inspection, the depth of overflow and its turbulence made it difficult to determine if the emergency spillway channel, its control section, or the side channel were

undergoing active erosion. We observed that at least one tree behind and below the right end of the dam had been lost since the Friday afternoon inspection, so we surmised that there was some loss of foundation rock below the "lip" of the control section. We could not determine if the "lip" of the control section had migrated closer to the right end of the gravity section. **(Photos 28, 29, 30, 31, 32, and 33, 34)**

3.3 ASSESSMENT OF CONDITIONS OBSERVED ON JULY 6

With the reservoir having reached an historic peak the previous night, we compared the observed pre-peak conditions on July 5 against the observed post-peak conditions on July 6 to reach the following conclusions:

1. The concrete gravity sections of the dam continued to appear to be stable, with no active signs of structural movements or distress.

2. The exposed foundation along the downstream toes of the left abutment and river sections of the concrete gravity sections continued to appear to be stable, with no signs of movement or excessive seepage.

3. The apparent leakage through the upper, horizontal construction joint in the left abutment and the river concrete gravity sections indicated that the joints were pressurized in conjunction with the reservoir's historic peak during the night.

4. There was a substantial zone in the foundation rock outcropping below the right concrete gravity section that was pressurized by seepage, even at the receded reservoir levels.

5. The concrete gravity sections very likely could have failed if either the dam had been overtopped or if the right abutment had been breached around the right end of the right abutment's concrete gravity section.

6. FNI's recommendation on Friday to the TNRCC to evacuate the public below Lake Medina Dam was prudent and appropriate, as the integrity of the dam could not have been assured under the conditions FNI observed Friday afternoon.

3.4 RECOMMENDATIONS ON JULY 6

The COE and FNI jointly agreed on the following recommendations, which were verbally relayed to the entire group participating in the joint inspection:

1 Assume that the dam will undergo a catastrophic failure if flood flows overtop the dam or if the right abutment is breached.

2. Do not allow flood flows to overtop the concrete gravity structures or allow the right abutment to be breached behind the right end of the right abutment's concrete gravity section.

3. Repair erosion damage to the right abutment behind the right end of the right abutment's concrete gravity section.

4. Monitor any future reservoir rises so that at least a 4-hour advance evacuation warning can be given to the public prior to the reservoir reaching the top of the dam.

5. Perform a detailed dam safety inspection and assessment as soon as the emergency spillway is no longer discharging.

Appendix A: Inspection Photographs

Photo 1 View of left abutment and crest of concrete gravity section, looking right. (Friday, July 5th)

Photo 2 View of **s**taff gage recording stage height (perhaps over the emergency spillway crest). The gage was located in the drawdown region upstream of the emergency spillway, as evidenced by the accelerated approaching flow and resulting standing wave around the gage. (Friday, July 5th)

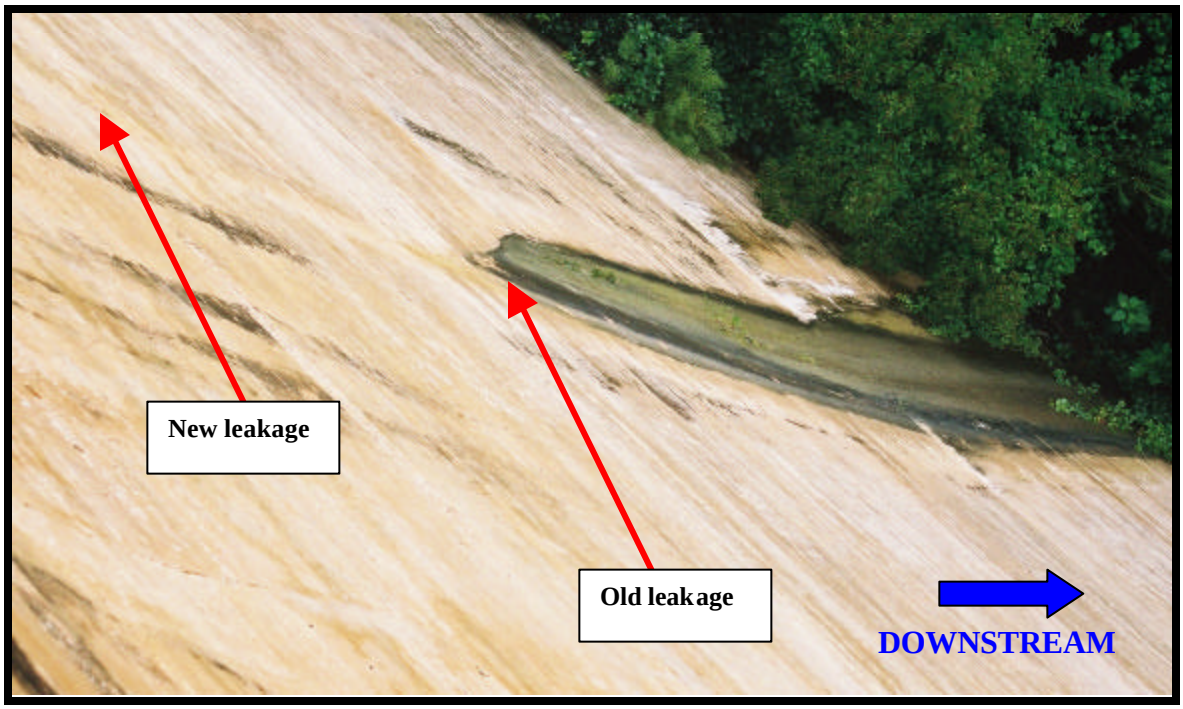


Photo 3 View of vertical crack in concrete gravity section-left abutment, looking right and downstream. Note the new leakage through the crack versus older, algae-stained leakage areas. (Friday, July 5th)

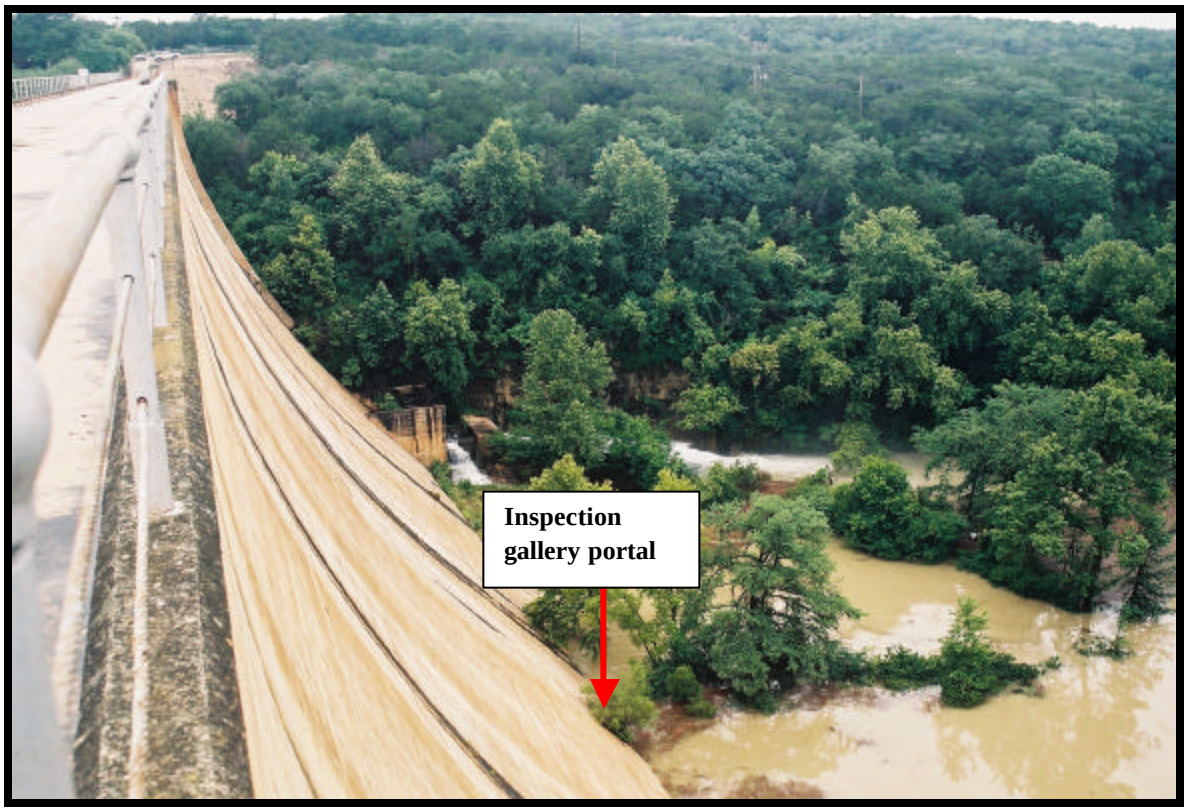


Photo 4 View of concrete gravity section-river, looking left and downstream. Note the tailwater level is just below the inspection gallery portal, which is obstructed by vegetation. (Friday, July 5th)

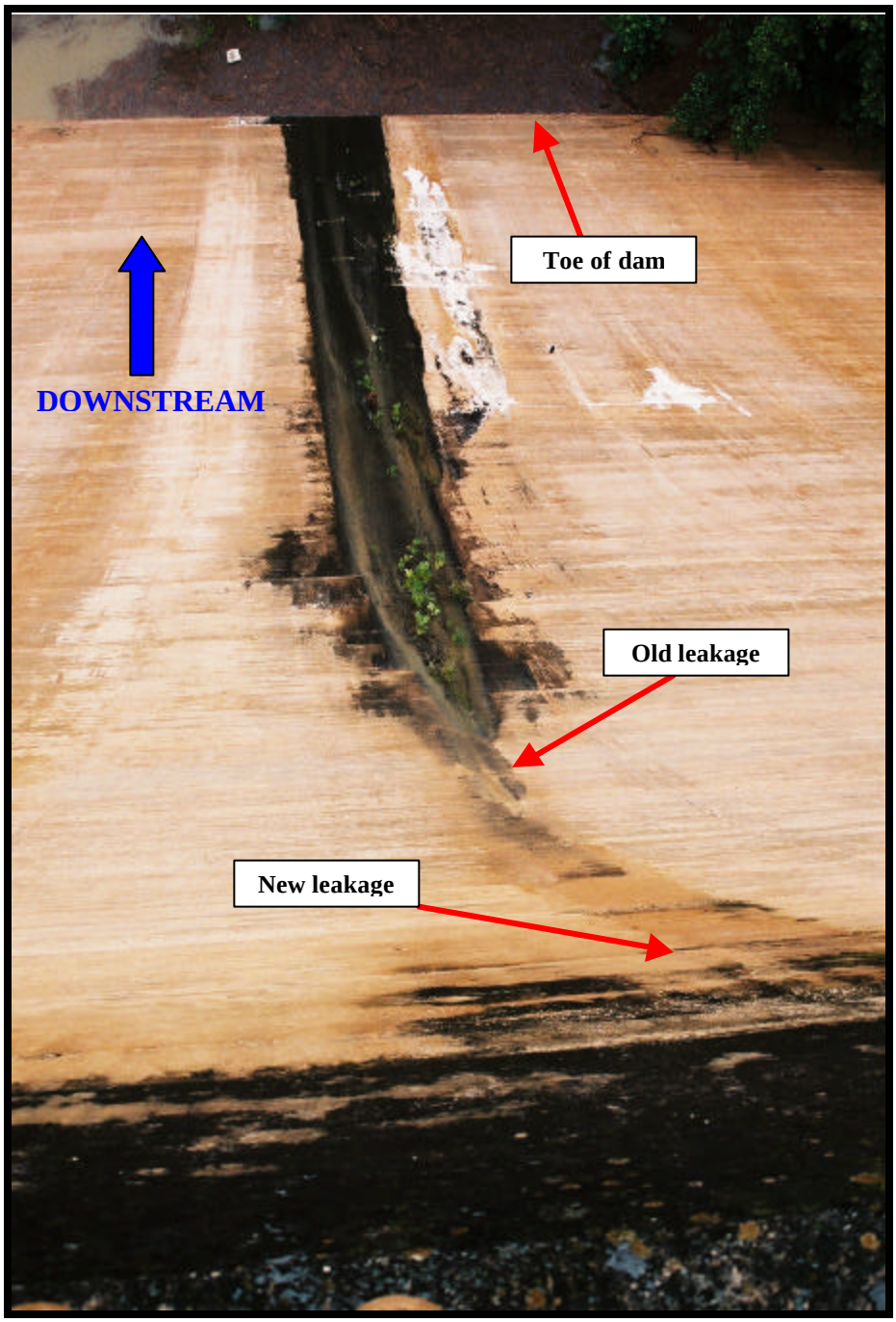


Photo 5 View of a vertical crack in the concrete gravity section-river, looking downstream. Note the new leakage through the crack versus older, algae-stained leakage areas. (Friday, July 5th)

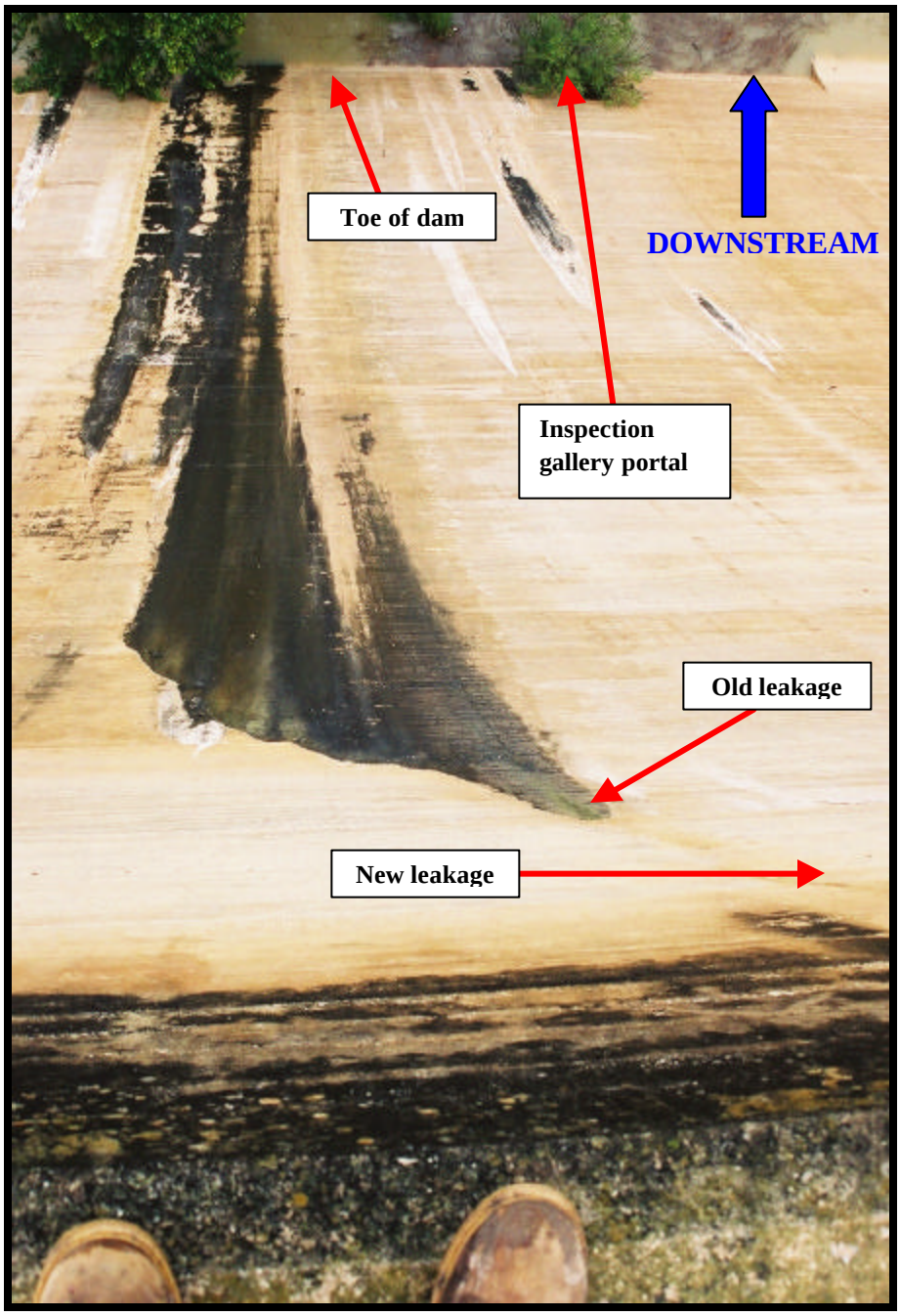


Photo 6 View of a vertical crack in the concrete gravity section-river, looking downstream. Note the new leakage through the crack versus older, algae-stained leakage areas. (Friday, July 5th)

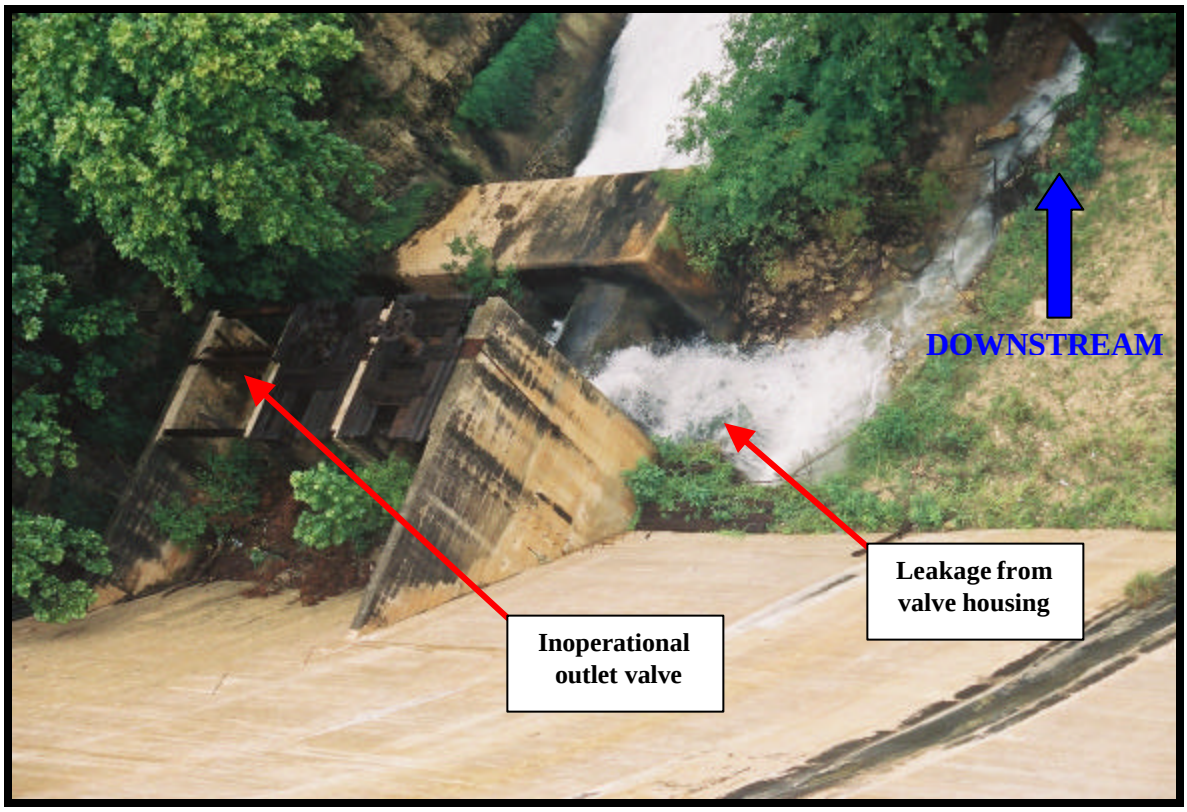


Photo 7 View of outlet works at the left end of the concrete gravity section-river, looking left and downstream. Note the valve on the right is discharging uncontrolled flow out the side of the valve housing. (Friday, July 5th)

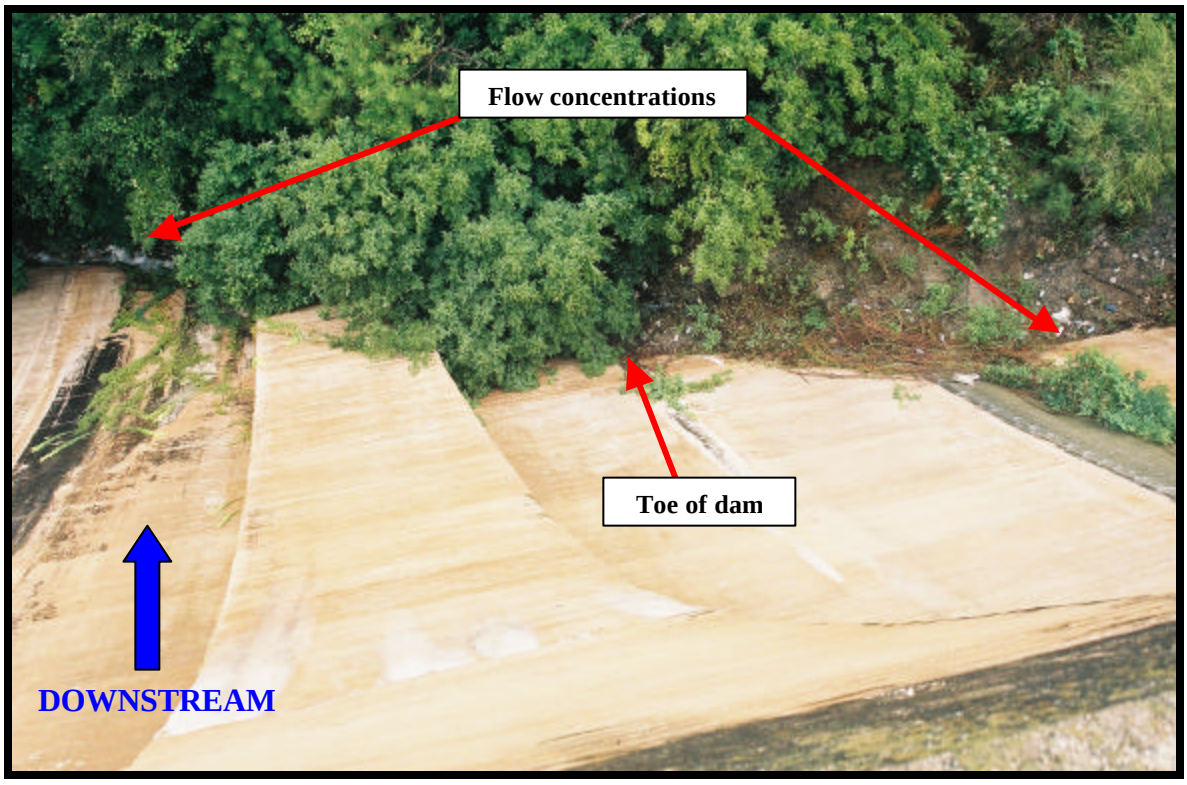


Photo 8 View of accumulated flow along toe of concrete gravity section-right abutment, looking downstream. (Friday, July 5th)

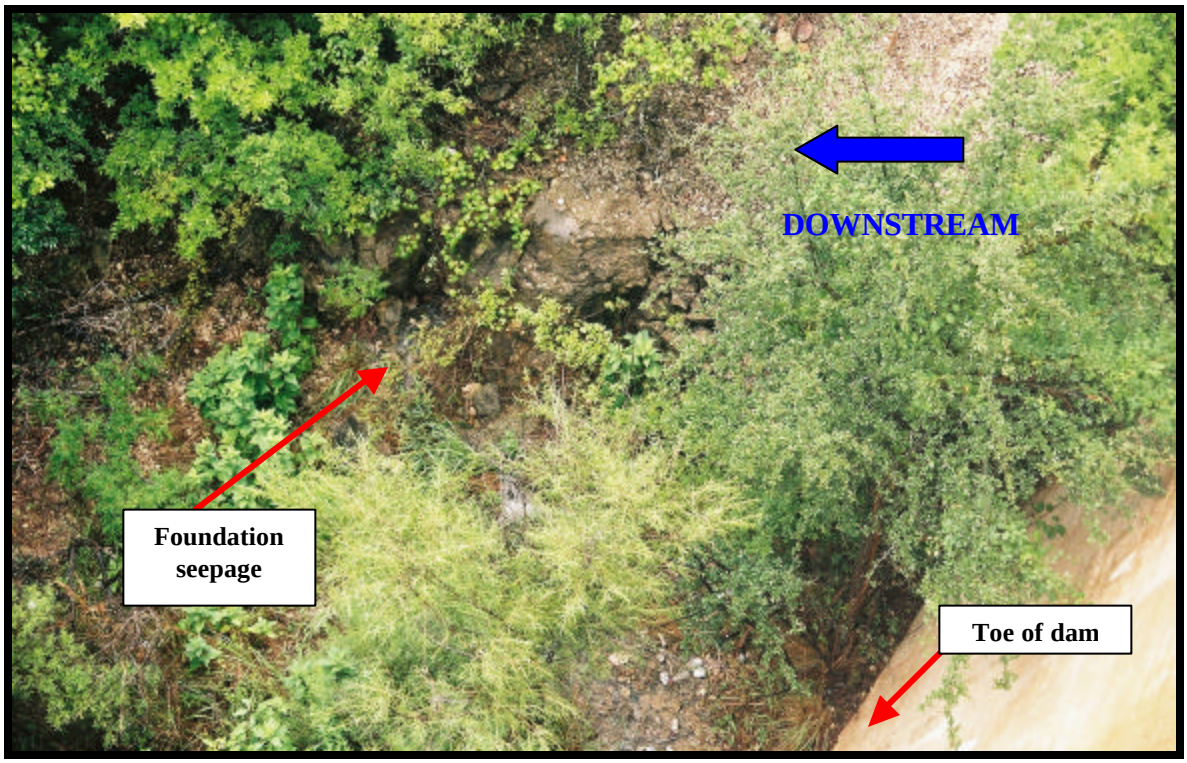


Photo 9 View of foundation seepage downstream of toe of dam, looking right and downstream. (Friday, July 5th)

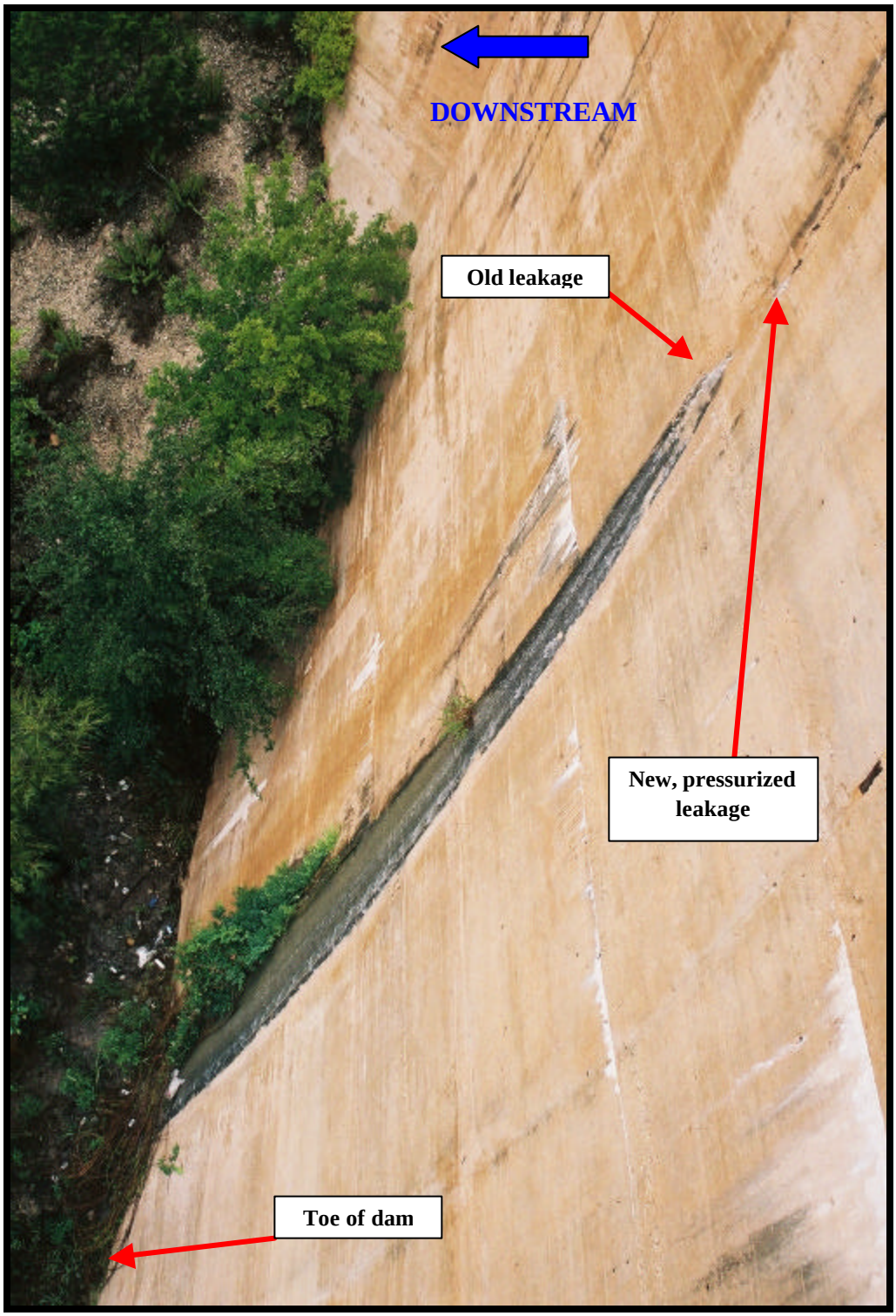


Photo 10 View of vertical crack in concrete gravity section-right abutment, looking right. Note the pressurized leakage exiting the crack several feet above the old, algae-stained leakage area. (Friday, July 5th)

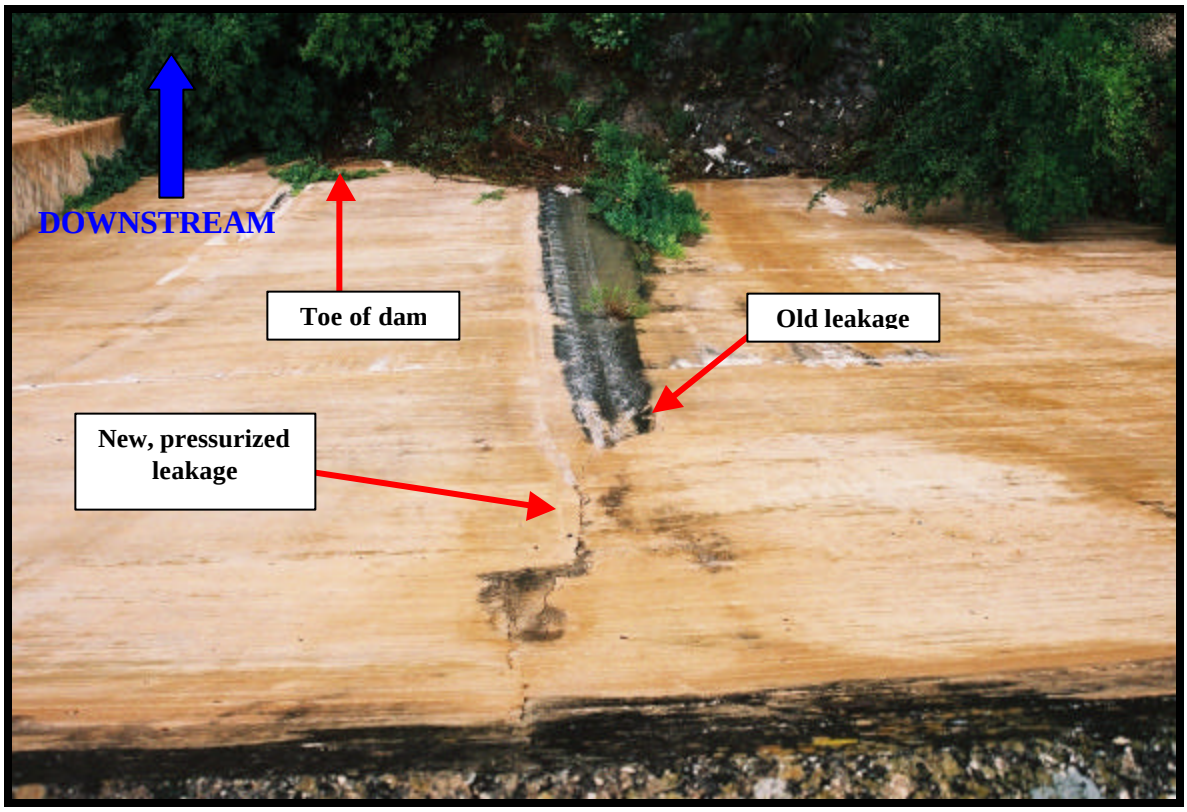


Photo 11 View of vertical crack in concrete gravity section-right abutment, looking downstream. Note the pressurized leakage exiting the crack several feet above the old, algae-stained leakage area. (Friday, July 5th)

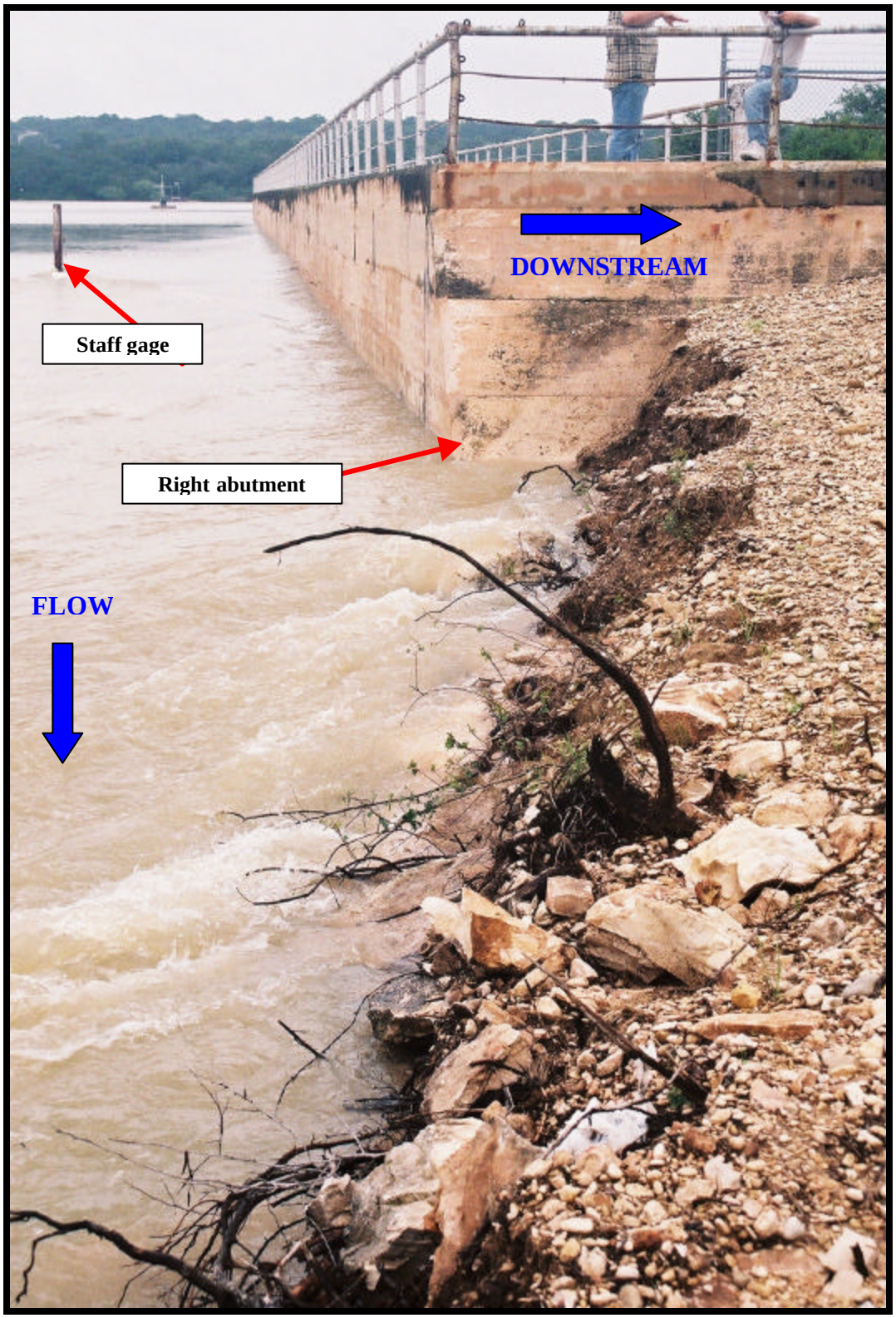


Photo 12 View of erosion along right abutment, looking left. Note the standing waves along the abutment. (Friday, July 5th)

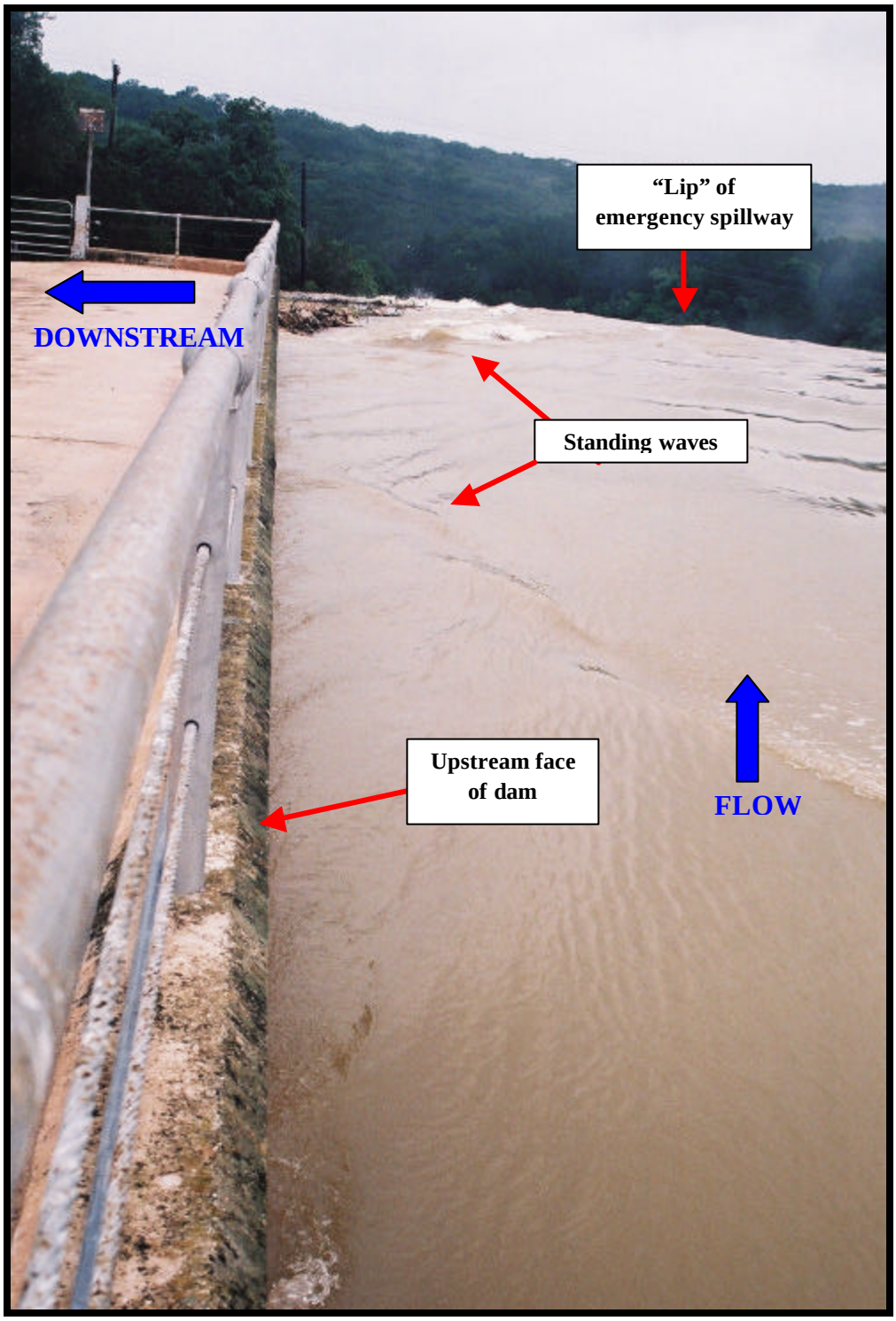


Photo 13 View of right abutment, looking right. Note the erosion along the abutment (see Photo 12) in the background. (Friday, July 5th)

Photo 14 View of erosion along right abutment, looking right. Note the standing waves along the abutment. (Friday, July 5th)

Photo 15 View of overtopping and erosion of left overbank, looking left. (Friday, July 5th)

Photo 16 View of discharge over emergency spillway, looking upstream from the right abutment. Note the turbulent flow and standing waves approaching the spillway "lip". (Friday, July 5th)

Photo 17 View of discharge over emergency spillway, looking upstream from the left overbank. Note the overtopping of the left overbank in the foreground. (Friday, July 5th)

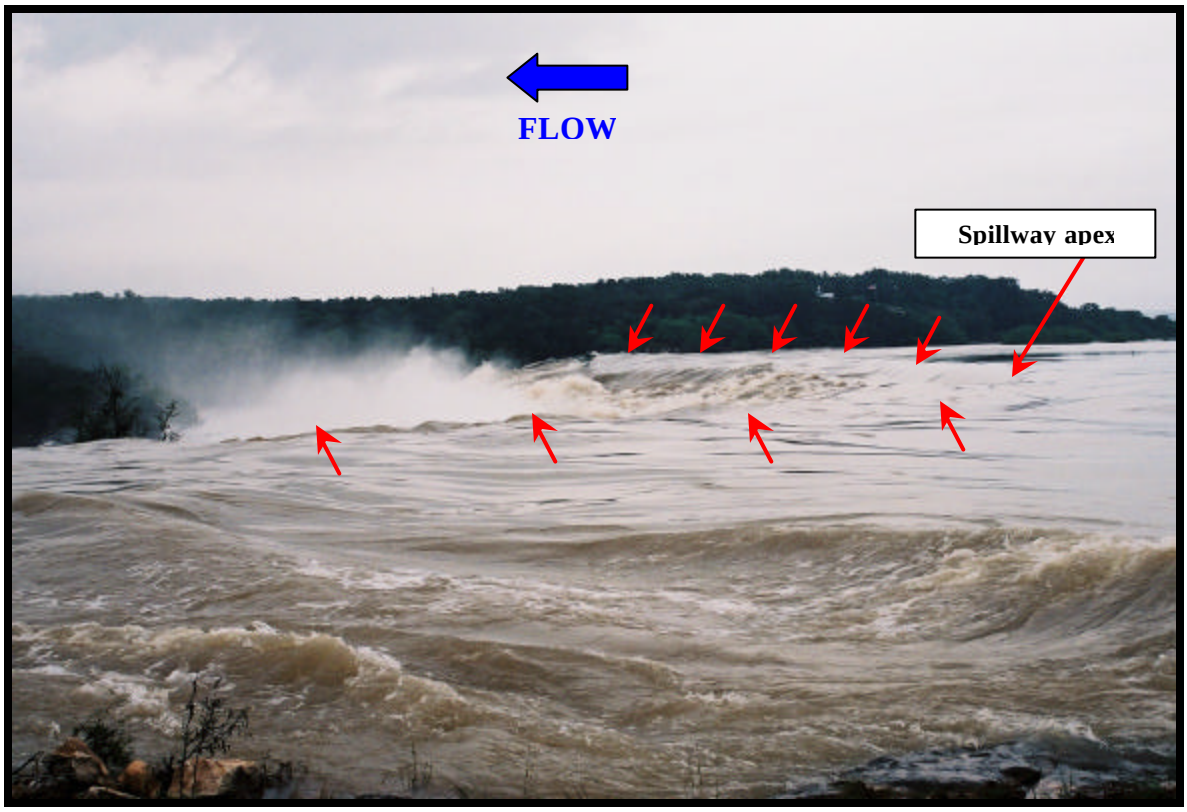


Photo 18 View of the emergency spillway, looking upstream from the right abutment. Note the concave alignment of the spillway lip and its apex at the near the midpoint. (Friday, July 5th)

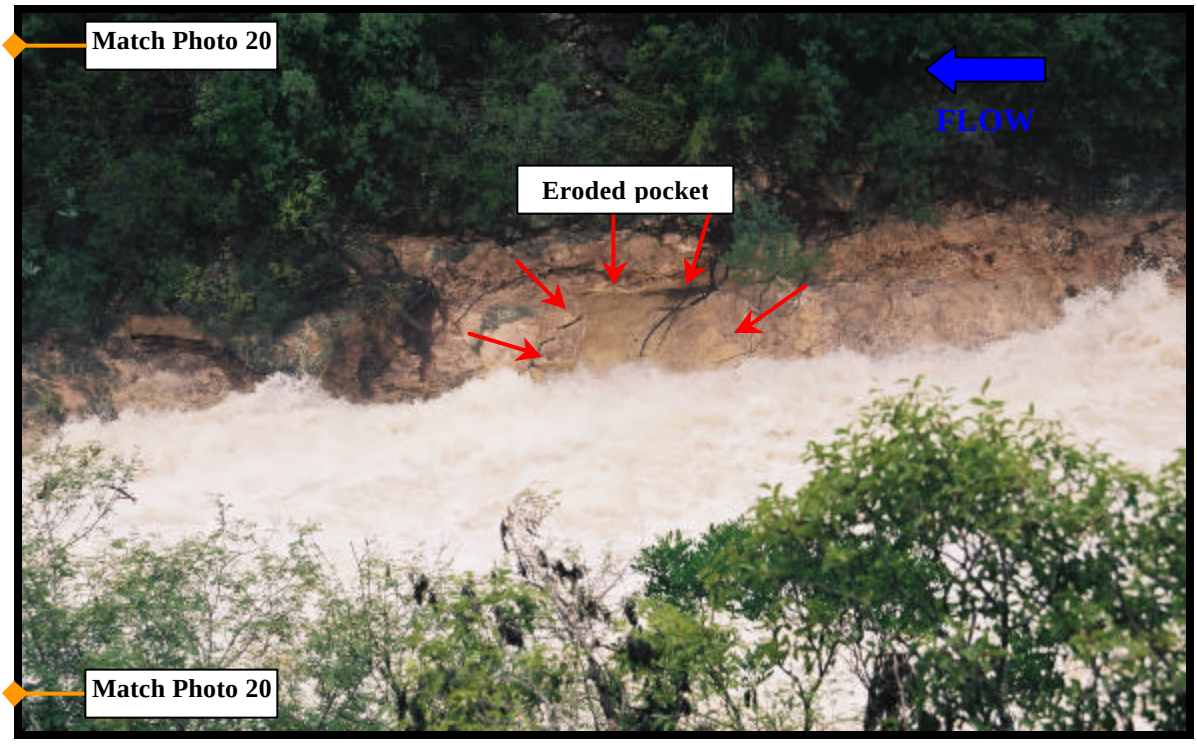


Photo 19 View of side channel, looking from left overbank. Note the newly eroded pocket in the opposite bank. (Friday, July 5th)

Photo 20 View of side channel, looking from left overbank. (Friday, July 5th)

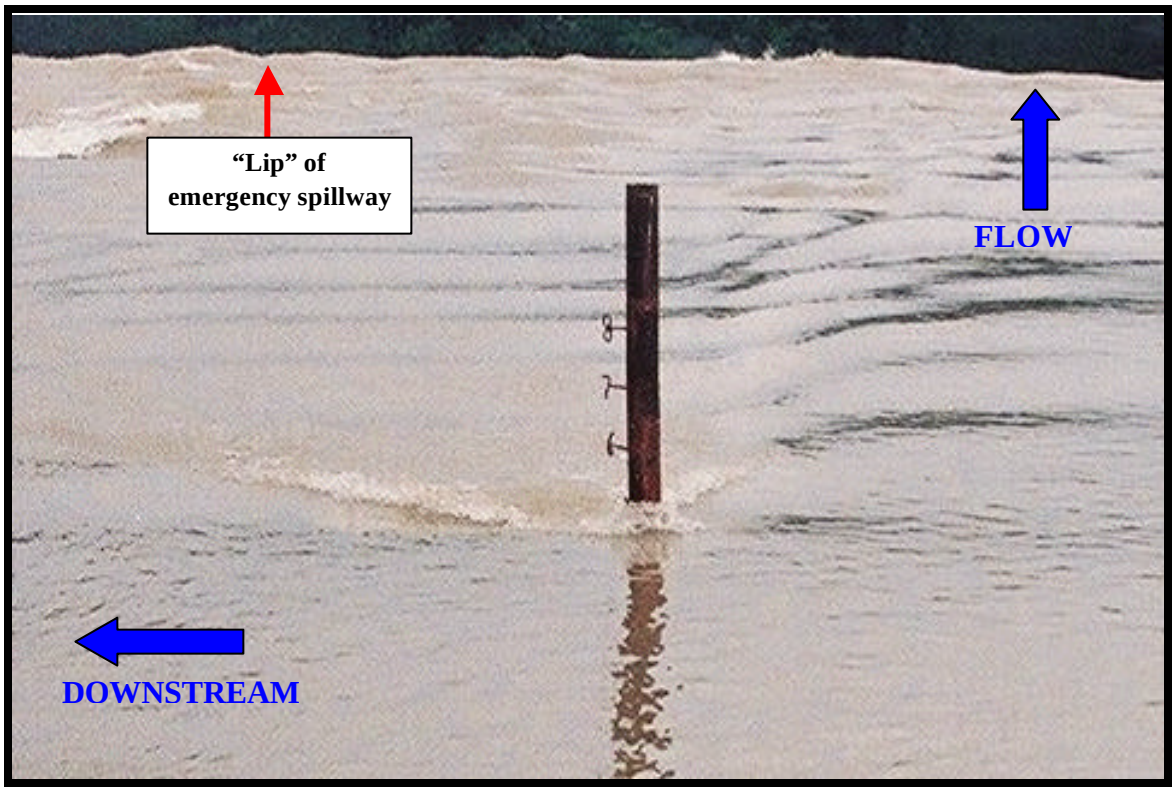


Photo 21 View of staff gage, looking right. (Saturday, July 6th)

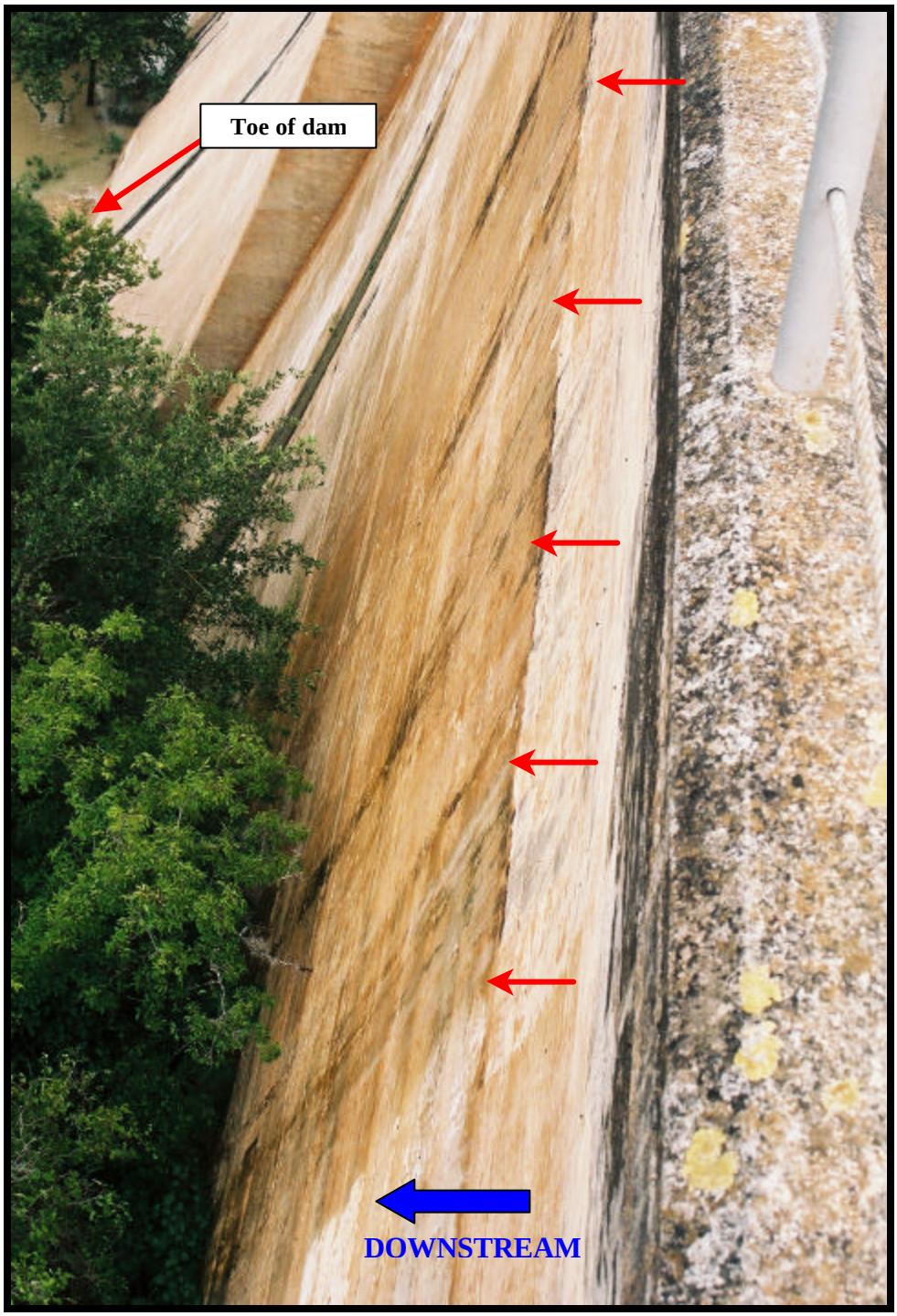


Photo 22 View of concrete gravity section-left abutment, looking right. Note the dampened section along a horizontal line. (Saturday, July 6th)

Photo 23 View of concrete gravity section-river, looking right. Note the dampened section along a horizontal line. (Saturday, July 6th)

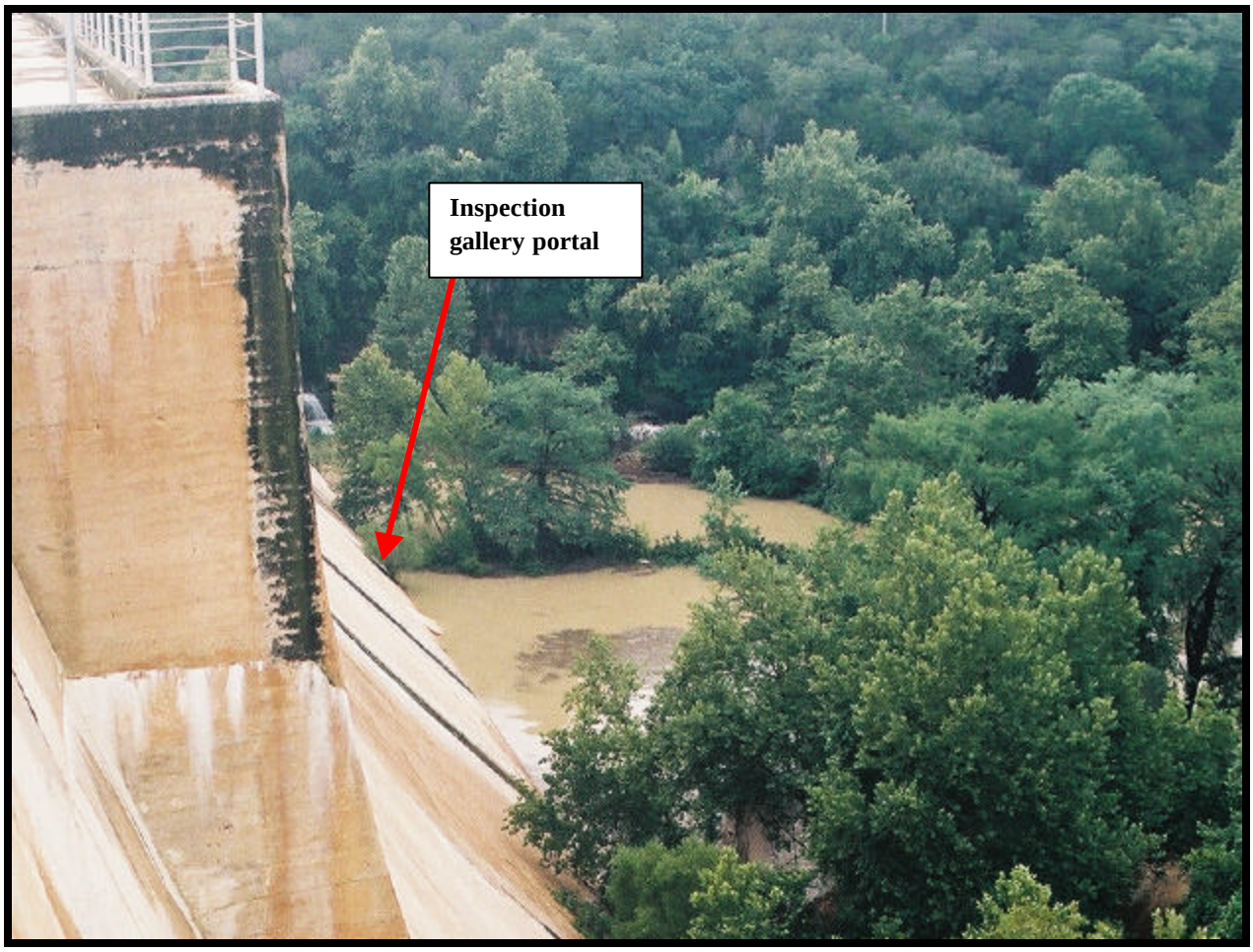


Photo 24 View of concrete gravity section-river, looking left and downstream. Note the tailwater level is just below the inspection gallery portal. (Saturday, July 6th)

Photo 25 View of foundation seepage downstream of toe of dam, looking right. (Saturday, July 6th)

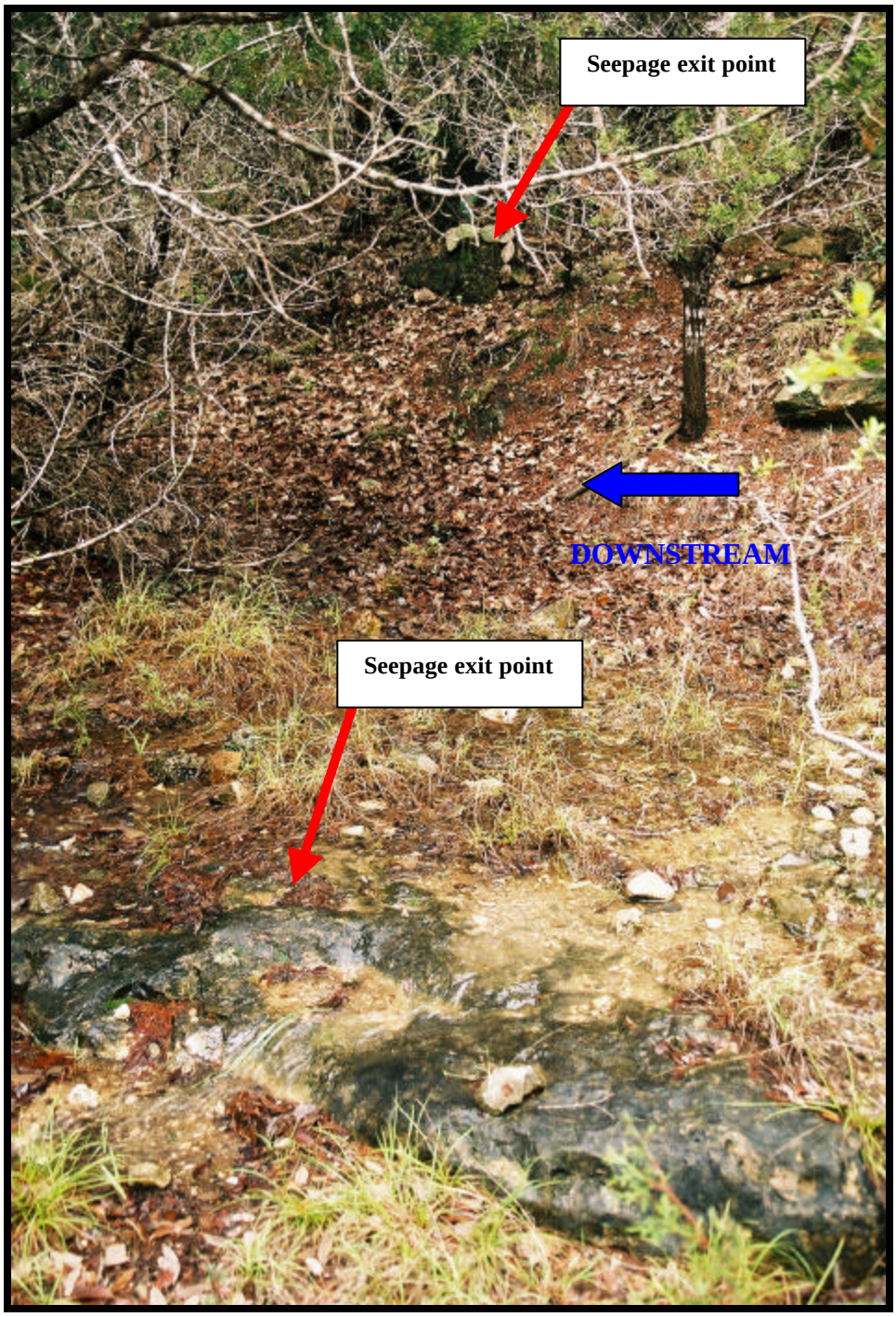


Photo 26 View of foundation seepage downstream of the dam. (Saturday, July 6th)

Photo 27 View of erosion along right abutment, looking right. (Saturday, July 6th)

Photo 28 Panoramic view of emergency spillway, looking right. (Saturday, July 6th)

Photo 29 Panoramic view of emergency spillway, looking right. (Saturday, July 6th)

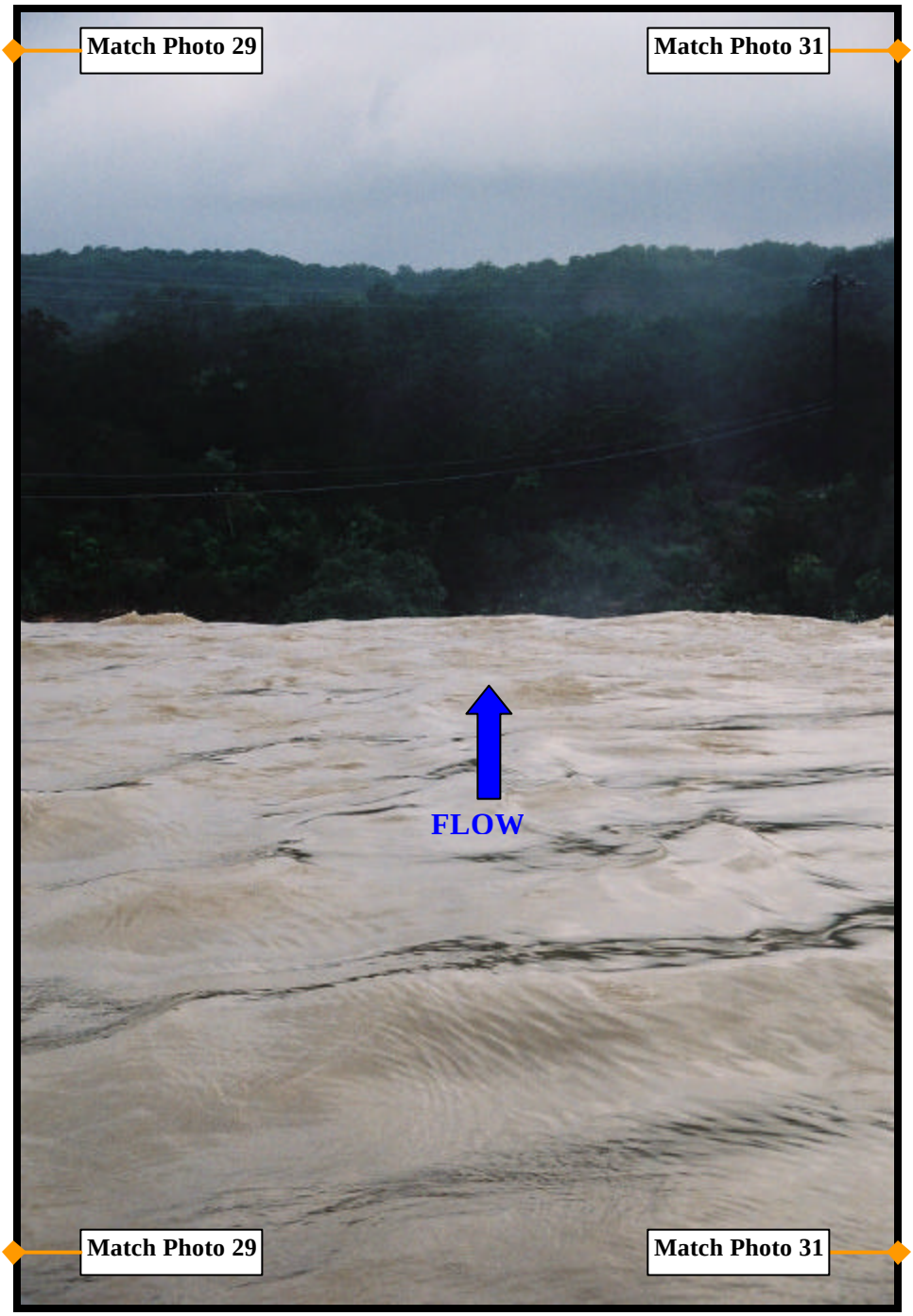


Photo 30 Panoramic view of emergency spillway, looking right. (Saturday, July 6th)

Photo 31 Panoramic view of emergency spillway, looking right. (Saturday, July 6th)

Photo 32 Panoramic view of emergency spillway, looking right. (Saturday, July 6th)

Photo 33 Panoramic view of emergency spillway, looking right. (Saturday, July 6th)