

CALIFORNIA DEPARTMENT OF WATER RESOURCES (DWR)

REVIEW REPORT OF SERIOUS ACCIDENT



San Luis Field Division Dive Fatalities

Date of Accident: February 7, 2007

Date of Report: December 10, 2007

By Serious Accident Review Team

A Board of Review has approved this report

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Introduction

This report summarizes the investigation of the February 7, 2007 diving accident at the State Water Project's Dos Amigos pumping plant by the Department of Water Resources (DWR) Serious Accident Investigation Team. The team was assembled at the request of DWR Director, Lester Snow.

The team was composed of staff from DWR, United States Bureau of Reclamation (USBR) and the California Department of Forestry and Fire Protection (CDF) employees.

The report is modeled after the guidelines set forth by the CDF Review Report of Serious Injuries, Illnesses, Accidents and Near-Miss Incidents.

The purpose of the report is to determine as accurately as possible what happened and determine, if possible, the cause or causes of the accident to help in preventing future accidents.

SITE CONDITIONS and CIRCUMSTANCES

DOS AMIGOS PUMPING PLANT

The accident occurred in the California Aqueduct just upstream of the Dos Amigos pumping plant (DAPP). DAPP is located approximately nine miles south of Los Banos, California in Merced County (See Figure 1). Water flows within the California Aqueduct by gravity from O'Neil Forebay to DAPP. The plant houses six pumps that lift water 113 feet where it then reenters the aqueduct downstream of the plant. The water is then able to flow by gravity within the aqueduct to the next pumping station 162 miles south of DAPP.



Figure 1

The aqueduct is a lined concrete trapezoidal channel, 110 feet wide at its base with 2:1 side slopes. The aqueduct flares out to the pumping plant which is 388 feet wide. The depth of water within the aqueduct varies, but is generally about 30 feet. A concrete deck crosses the intake above the trashracks (See Figures 2 and 3).

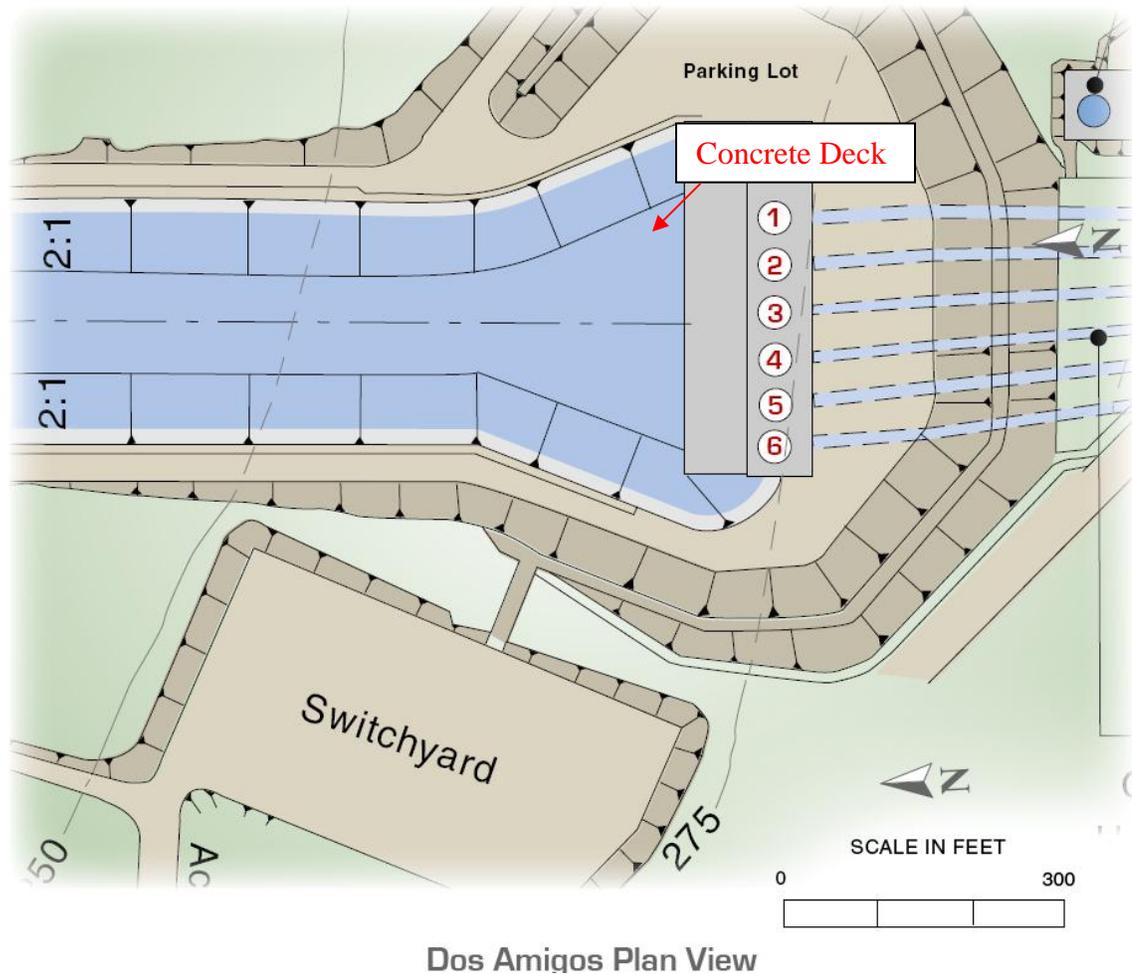
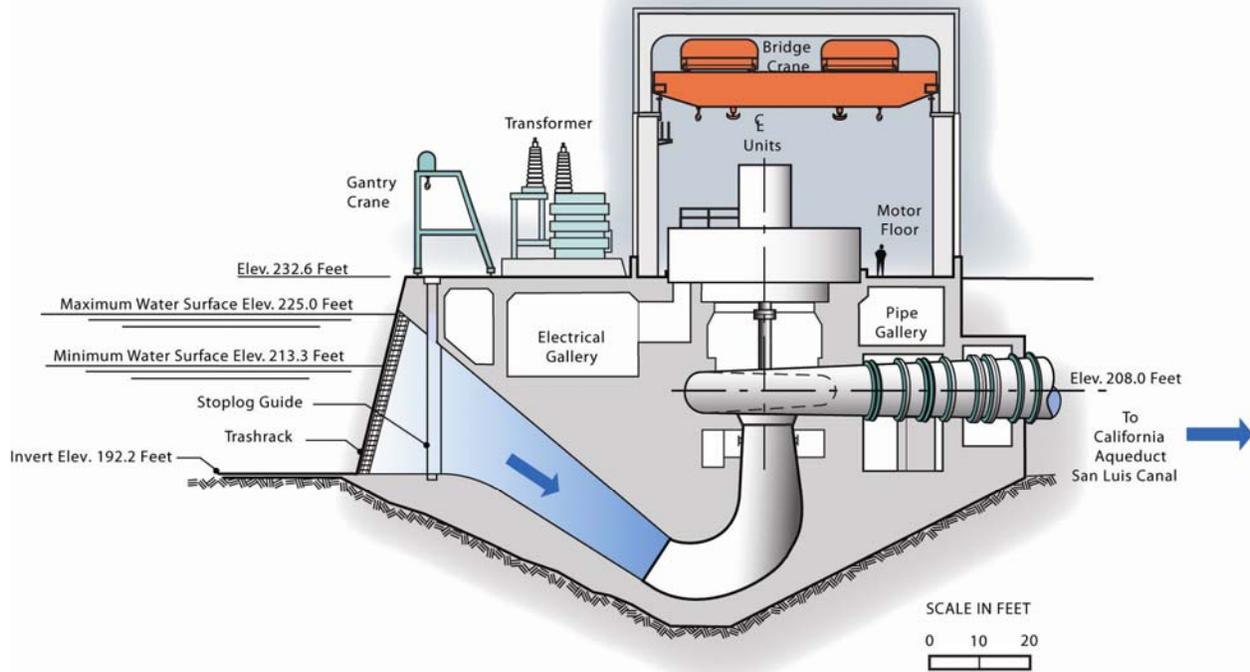


Figure 2

Each unit is capable of pumping approximately 2700 cfs. The pumps are numbered Units 1 to 6 with Unit 1 located on the east side of the plant and Unit 6 located on the west side of the plant (See Figure 2). Units 1, 3 and 5 are variable speed, capable of pumping any amount of flow between half and full capacity. Units 2, 4 and 6 can pump only at full capacity or off. Shutting off the pumps causes water to momentarily reverse the direction of the water flow back into the aqueduct. Observations by team members during recent tests confirm that shutting down a pump results in reverse flow that causes water to push any accumulated debris approximately 30 to 50 feet upstream.



Dos Amigos Cross Section

Figure 3

Each pump is protected by three trashracks, each about 34 feet tall by 10 feet wide. The trashracks are made of steel bars that have a spacing of six inches. The trashracks are inclined at an angle of 14 degrees from vertical (See Figure 3). The purpose of the trashracks is to prevent large debris from entering the pumps. Debris buildup clogs the trashracks of operating units, which can have a significant effect on water velocities near the trashracks.

DAPP has a mechanical trashrack cleaner. However, the trashrack cleaner has not been working for several years. Debris is periodically being removed from the trashracks with an excavator.

DAPP is operated by the Area Control Center, located at the DAPP, in combination with the Project Operation Center, located in Sacramento. All operations of the plant are closely monitored and coordinated since any operation of the DAPP could have an impact to the overall operation of the State Water Project. Each action taken at the plant is logged through a computer data control system.

The pumps are operated based on the deliveries estimated annually, environmental restrictions, power costs and required maintenance. On February 7, 2007 the pumps' scheduled operation was as follows:

| Pump | Operation – February 7, 2007 |
|-------------|---|
| 1 | 0000 to 2200 hrs - Out of Service |
| 2 | 0000 to 0510 hrs – Shutdown ¹ 05:20 to 18:20 – Out of Service ² 18:30 to 18:50 – Shutdown 19:00 to 22:00 – In Service ³ |
| 3 | 00:00 to 05:10 - Shutdown 05:20 to 18:20 - Out of Service 18:30 to 18:50 - Shut down 19:00 - Out of Service 19:10 to 22:00 - In Service |
| 4 | 00:00 to 22:00 – Shutdown |
| 5 | 00:00 to 11:30 – In Service at full capacity 1130 to 1150 hrs – In Service at half capacity 1150 to 2200 – Shut down |
| 6 | 00:00 to 06:50 - In Service 07:00 to 22:00 - Shut down |

¹Shutdown – The pump is not operating, but is available for service if required

²Out of Service – The pump is off due to maintenance or other requirement

³In Service – The pump is operating

The dive on February 7, 2007 was scheduled to coincide with planned outages of Units 1, 2 and 3. These units were shutdown for routine testing of the transformers.

SEQUENCE OF EVENTS

The following sequence was developed by the Serious Accident Investigative Team after gathering information from interviewing staff, reviewing reports and other data generated from the accident.

On February 1, 2007, DWR San Luis Field Division (SLFD) Dive Supervisor Tim Crawford submitted, via email, a Notice of Dive at Dos Amigos Pumping Plant. Crawford emailed the notice to his supervisors and other necessary parties.¹ The notice included the names of three divers scheduled to participate in the dive, and listed the dive tender as civil maintenance. That same day in response to this notice, the SLFD Area Control Center (ACC) Hydro Electric Plant Senior Operator (Senior Operator #1) on duty at the time of the incident, processed a Work Clearance Application.² This document noted the divers would be searching for zebra mussels in front of Units 1, 2 and 3 and those units would be out of service for testing on transformer K3A during the dive. The document also noted that Senior Operator #1 informed Crawford that Units 4, 5 and 6 could be running that day.

On February 7, 2007 during the time of the dive, Units 1, 2 and 3 were out of service. Units 2 and 3 were taken out of service at 0518 hours, while Unit 1 was already out of service. Units 4 and Unit 6 were shut down during the time of the dive. Unit 5 was operating at full capacity during the time of the dive.

At about 0715 to 0730 hours at the San Luis Field Division offices, the Safety Officer (one of the three divers scheduled to participate in the dive) informed Crawford that he had a meeting during the scheduled dive time and could not perform the dive.³ Crawford assured the Safety Officer that he and Martin Alvarado, the third diver scheduled to participate in the dive, could do the dive without him.⁴ Crawford asked another DWR employee to be the dive tender for the dive.⁵ Crawford and Dive Tender drove to the DAPP, a distance of approximately 20 miles.

At about 0815 hours, Crawford and Dive Tender met in the DAPP parking lot.⁶ Alvarado arrived at about 0900 hours, and the three men went into the ACC to discuss the pump operations with the plant operators⁷. Crawford and one of the operators (Plant Operator) discussed the dive⁸. The Plant Operator informed Crawford that Unit 5 was the only pump operating at the time and that the divers would be notified if there were changes to the operation of the units.⁹ The Plant Operator recalls Crawford told

¹ Email from Crawford dated February 1, 2007.

² Work Clearance Application dated February 1, 2007.

³ Interview with SLFD Health and Safety Officer on February 9, 2007.

⁴ Interview with SLFD Health and Safety Officer on February 9, 2007.

⁵ Interview with Dive Tender on February 9, 2007; Interview with Utility Craftworker #1 on February 14, 2007.

⁶ Interview with Dive Tender on February 9, 2007.

⁷ Interview with Dive Tender on February 9, 2007.

⁸ Interview with Plant Operator on February 14, 2007.

⁹ Interview with Plant Operator on February 14, 2007.

him that the Dive Tender would be tending, and Crawford requested the Plant Operator inform the Dive Tender of any changes in pumping operations.¹⁰

Crawford, the Dive Tender and Alvarado returned to the dive van and Crawford and Alvarado suited up.¹¹ Alvarado had new dive equipment and was taking his equipment directly out of the boxes and putting it on. The Dive Tender recalls Crawford and Alvarado discussed Alvarado's new equipment as they prepared for the dive.¹² The Dive Tender observed that Alvarado's weight belt appeared tight and Dive Tender asked Alvarado if he could reach the release cords. The Dive Tender recalls Alvarado saying that he thought he could reach them.¹³ At 0933 hours Crawford notified the Plant Operator that they were preparing to go in the water.¹⁴ The Plant Operator gave them the clearance to go in the water and begin the dive. The Plant Operator submitted a work clearance document for the dive at that time and entered it into the log at 0944 hours.¹⁵

Between 0930 hours and 0945 hours, Utility Craftworker #1 drove into the parking lot as Crawford and Alvarado were checking their equipment.¹⁶ The Utility Craftworker #1 offered to assist as dive tender, but both Dive Tender and Crawford declined his offer. The Utility Craftworker #1 heard Crawford and the Dive Tender discussing the dive. The Dive Tender asked Crawford about using the communication equipment and the Dive Tender recalls Crawford replying that he did not like to use ropes around pumping plants. Crawford told the Dive Tender to follow their bubbles and that they would only be by Units 1, 2 and 3.¹⁷ At about 0945 hours, the Utility Craftworker #1 left the parking lot. The divers continued to put on their equipment.

At 1010 hours, the Dive Tender observed the divers as they finished putting on their equipment and walked to the edge of the bank near Unit 1 and climbed down the east slope of the aqueduct to the water.¹⁸ Both divers had on their hoods, diving boots, weight belts, buoyancy compensators, tanks and dry suits. The Dive Tender recalls Crawford clipped a tether to his equipment and Alvarado grabbed the other end, but the Dive Tender could not remember if Alvarado held the end or looped it around his wrist. The Dive Tender asked Crawford whether he and Alvarado were going to use a tether to the surface. Dive Tender recalls Crawford replying no, that if Dive Tender wanted to get their attention while they were in the water, to bang on the grates. The Dive Tender went to the van, retrieved a fire hoe, safety rope and a lifesaver ring and returned to the deck.¹⁹ Crawford and Alvarado conducted their equipment check and discussed

¹⁰ Interview with Plant Operator on February 14, 2007.

¹¹ Interview with Dive Tender on February 9, 2007.

¹² Interview with Dive Tender on February 9, 2007.

¹³ Interview with Dive Tender on February 9, 2007.

¹⁴ Work clearance document dated February 7, 2007; Interview with Plant Operator on February 14, 2007.

¹⁵ Area Control Center Log; Interview with Plant Operator on February 14, 2007.

¹⁶ Interview with Utility Craftworker #1 on February 14, 2007.

¹⁷ Interview with Utility Craftworker #1 on February 14, 2007.

¹⁸ Interview with Dive Tender on February 9, 2007.

¹⁹ Interview with Dive Tender on February 9, 2007; Interview with Plant Operator on February 14, 2007.

Alvarado's new mouthpiece. Crawford and Alvarado put on their face masks, inserted their mouthpieces and went under water.²⁰ Immediately thereafter, both divers came up out of the water. Alvarado adjusted his face mask and both divers submerged.²¹

At about 1015 hours, the Dive Tender watched from the deck and observed two distinct bubble patterns surface after the divers submerged for the dive. Dive Tender followed the surfacing bubbles starting at Unit 1 and continuing to Units 2, 3 and 4. This took approximately 10-13 minutes. When the bubbles surfaced somewhere in front of Unit 4 (or between Units 4 and 5), Dive Tender observed the bubbles began to sweep towards Unit 5 and then disappeared²². At about 1035, he crossed the deck past Unit 5 looking for the bubbles to reappear. The Dive Tender went over to the far edge of the deck. He thought he saw something but realized it was just bubbles from a sump pump pipe. After searching for bubbles back and forth across the deck, Dive Tender called Senior Operator #2 by cell phone at 1045 hours and informed him that he could not see the diver's bubbles or otherwise locate the divers.²³ During the phone conversation, Senior Operator #2 agreed to send Plant Operator to the deck to assist the Dive Tender in looking for the divers' bubbles.²⁴ Immediately after calling the operator, Dive Tender called the Safety Officer, the other diver originally scheduled to participate in the dive, but the Safety Officer did not answer his phone.²⁵ Plant Operator arrived on deck at 1054 hours. Plant Operator and Dive Tender went back and forth across the deck and continued to look for any sign of the divers, but did not see any bubbles.²⁶

At 1053 hours, Senior Operator #2 in the ACC moved the surveillance camera, which is located at the entrance to the pumping plant, to pan the deck and the units. He did not see any bubbles. At approximately 1055 hours, Senior Operator #2 called Safety Officer, but Safety Officer did not answer his phone.²⁷

At 1112 hours, the SLFD Chief Engineer and another engineer arrived on the deck on unrelated business.²⁸ Dive Tender explained the situation to SLFD Chief Engineer who then called the main office for further assistance. At 1114 hours, SLFD Chief Engineer contacted the field division chief (SLFD Chief) who got a message to the Safety Officer. At 1119 hours, the Safety Officer returned SLFD Chief Engineer's call.²⁹ SLFD Chief Engineer told the Safety Officer that Dive Tender had lost sight of the bubbles and the divers had been in the water more than one hour. Safety Officer replied that something

²⁰ Interview with Dive Tender on February 9, 2007.

²¹ California Highway Patrol Interview with Dive Tender on March 8, 2007.

²² Interview with Dive Tender on February 9, 2007.

²³ Interview with Dive Tender on February 9, 2007; Interview with plant operator Senior Plant Operator #2 on February 14, 2007; Area Control center log.

²⁴ Interview with Senior Plant Operator #2 on February 14, 2007; Interview with Dive Tender on February 7, 2007.

²⁵ Interview with Dive Tender on February 9, 2007.

²⁶ Surveillance video dated February 7, 2007.

²⁷ Interview with Senior Plant Operator #2 on February 14, 2007; Surveillance video dated February 7, 2007.

²⁸ Surveillance video dated February 7, 2007; Interview with SLFD Chief Engineer on February 14, 2007.

²⁹ Interview with SLFD Chief Engineer on February 14, 2007; Interview with Dive Tender on February 9, 2007; Cellular telephone records.

was wrong and he would immediately drive from the SLFD main office to the DAPP.³⁰ While SLFD Chief Engineer was making these calls, the Dive Tender repeatedly beat on the grates with the hoe in an attempt to make contact with the divers, with no response.³¹ At 1130 hours, Senior Operator #2 requested and obtained permission to reduce the flow on Unit 5 by 50%.³²

The Safety Officer arrived on deck at 1138 hours. At approximately 1140 hours, the Safety Officer went to the dive van to prepare to dive in the aqueduct to search for Crawford and Alvarado.³³ As the Safety Officer was suiting up to go in the water, he noticed that his weight belt was not in the dive van. The Safety Officer found another weight belt in the van, but it did not have any weights, nor were there any weights in the dive van.³⁴ The Safety Officer contacted maintenance supervisor Assistant Utilities Craftworker Supervisor (Supervisor) at the SLFD office and requested he bring the Safety Officer weights from the dive locker.³⁵

SLFD Chief arrived on deck at 1146 hours.³⁶ He ordered Unit 5 shut down and 911 be called.³⁷ Unit 5 was shut down at 1150 hours.³⁸ When the units were shut down, several staff on the deck observed a few bubbles approximately 30 to 50 feet from the trashrack in front of Unit 5.³⁹ At about 1214 hours, responding to the 911 call, a Merced County sheriff's officer arrived on deck.⁴⁰

When the Supervisor arrived with the weights, the Safety Officer finished suiting up. At 1226 hours, he climbed over the deck rail at Unit 5, entered the water and swam towards the surfacing bubbles.⁴¹ The Safety Officer was tethered from the surface above the Unit 5 trashrack with surface to water communication.⁴² The Dive Tender directed the Safety Officer from the surface using communication gear.

The Safety Officer reached the bubbles, approximately 30 to 50 feet from the trashrack in front of Unit 5, where he discovered a diver face down near the bottom of the aqueduct.⁴³ The Safety Officer stated that the diver, Alvarado, was unresponsive and

³⁰ Interview with SLFD Chief Engineer on February 14, 2007; Interview with SLFD Health and Safety Officer on February 9, 2007.

³¹ Interview with Dive Tender on February 9, 2007.

³² Interview with Senior Operator #2 on February 14, 2007; Area Control Center log.

³³ Surveillance video dated February 7, 2007; Interview with SLFD Health and Safety Officer on February 9, 2007.

³⁴ Interview with SLFD Health and Safety Officer on February 9, 2007.

³⁵ Interview with SLFD Health and Safety Officer on February 9, 2007.

³⁶ Surveillance video dated February 7, 2007.

³⁷ Interview with SLFD Chief on February 9, 2007; Interview with Senior Operator #2 on February 14, 2007.

³⁸ Area Control Center log.

³⁹ Interview with SLFD Health and Safety Officer dated February 9, 2007; Interview with Dive Tender on February 9, 2007; Interview with Plant Operator dated February 14, 2007; Interview with SLFD Chief on February 9, 2007.

⁴⁰ Surveillance video dated February 7, 2007.

⁴¹ Surveillance video dated February 7, 2007; Interview with SLFD Health and Safety Officer on February 9, 2007; Interview with Dive Tender on February 7, 2007.

⁴² Interview with SLFD Health and Safety Officer on February 9, 2007; Interview with Dive Tender on February 9, 2007.

⁴³ Interview with SLFD Health and Safety Officer on February 9, 2007.

that he saw Alvarado's regulator out of his mouth.⁴⁴ He also noticed bubbles but he could see that they were not coming from Alvarado's regulator.⁴⁵ He grabbed Alvarado's tank and directed individuals on the deck to pull Alvarado and him toward the deck.⁴⁶ The staff on deck pulled on the cable which attaches the communication gear to Safety Officer.⁴⁷ At 1233 hours, when they reached the water's surface, the Safety Officer tied off Alvarado's tank to the deck.⁴⁸ A witness observed some bubbles approximately five feet behind the Safety Officer as he was holding Alvarado.⁴⁹

The Safety Operator submerged and discovered Crawford within a few feet of where he pulled Alvarado out of the water. Crawford was unresponsive. At approximately 1241 hours, the Safety Operator grabbed Crawford's tank, brought him to the surface and tied him off.⁵⁰ Between 1252 hours and 1300 hours, staff utilized heavy equipment to assist in the recovery of the divers from the aqueduct onto the deck.⁵¹ As staff removed Alvarado and Crawford from the water, the Safety Officer noticed that Alvarado's buoyancy compensator vest (BC), which connects together by Velcro and snaps, was not connected.⁵² DWR employees assisted emergency personnel in cutting off the divers' equipment and drysuits and observed Alvarado had some fishing line wrapped around his feet and ankles.⁵³ Resuscitation efforts were made.⁵⁴ Alvarado and Crawford were transported to the hospital where Crawford was pronounced dead at 1329 hours and Alvarado was pronounced dead at 1346 hours.⁵⁵

⁴⁴ Interview with SLFD Health and Safety Officer on February 9, 2007.

⁴⁵ Interview with SLFD Health and Safety Officer on February 9, 2007.

⁴⁶ Interview with SLFD Health and Safety Officer on February 9, 2007.

⁴⁷ Interview with Dive Tender on February 9, 2007; Interview with SLFD Health and Safety Officer on February 9, 2007.

⁴⁸ Interview with Dive Tender on February 9, 2007; Interview with SLFD Health and Safety Officer on February 9, 2007; Surveillance video dated February 7, 2007.

⁴⁹ Interview with DWR Engineer dated February 13, 2007.

⁵⁰ Interview with SLFD Health and Safety Operator on February 9, 2007; Surveillance video dated February 7, 2007.

⁵¹ Interview with SLFD Health and Safety Operator on February 9, 2007; Interview with Dive Tender on February 9, 2007; Interview with Plant Operator on February 14, 2007; Interview with SLFD Chief on February 9, 2007; Surveillance video dated February 7, 2007.

⁵² Interview with SLFD Health and Safety Operator on February 9, 2007.

⁵³ Interview with SLFD Health and Safety Operator on February 9, 2007; Interview with Utility Craftswoman #2 on February 14, 2007.

⁵⁴ Interview with SLFD Health and Safety Operator on February 9, 2007; Interview with Utility Craftswoman #2 on February 14, 2007.

⁵⁵ Death Certificates of Martin Alvarado and Tim Crawford.

SIGNIFICANT TIME EVENTS

Surveillance Video on February 7, 2007

| Time | Event |
|------------|---|
| 10:30 a.m. | Video begins |
| 10:53 a.m. | Search using surveillance video begins |
| 10:54 a.m. | Plant Operator arrives on deck |
| 11:16 a.m. | SLFD Chief Engineer first noticed on deck. Based on Dive Tender reaction it appears SLFD Chief Engineer arrives at 11:12 a.m. |
| 11:16 a.m. | SLFD Chief Engineer noticed making phone call |
| 11:38 a.m. | SLFD Health and Safety Officer first noticed on deck |
| 11:40 a.m. | SLFD Health and Safety Officer goes to dive van |
| 11:46 a.m. | SLFD Chief first noticed on deck |
| 12:14 p.m. | First Sheriff arrives |
| 12:26 p.m. | SLFD Health and Safety Officer enters water |
| 12:33 p.m. | Diver 2 recovered (Martin Alvarado) |
| 12:41 p.m. | Diver 1 recovered (Tim Crawford) |
| 12:46 p.m. | Excavator brought on deck |
| 12:52 p.m. | Diver 1 removed from aqueduct |
| 1:00 p.m. | Diver 2 removed from aqueduct |
| 2:15 p.m. | Video ends |

| | |
|------------------------------|---|
| Dive Tender | Dark Shirt with Dark hat |
| Plant Operator | Greenish shirt with baseball cap |
| SLFD Chief Engineer | Dark vest over light-colored shirt with white hardhat |
| SLFD Health & Safety Officer | Dark Shirt. No hat. |
| SLFD Chief | Brown-tan coat, dark pants. No hat |

Cellular Telephone Records

| Time | Event |
|------------|--|
| 11:14 a.m. | SLFD Chief Engineer phone call to SLFD Health & Safety Officer |

Area Control Center Logs

| Time | Event |
|------------|--|
| 05:18 a.m. | Units 2 and 3 unavailable – Scheduled outage |
| 09:33 a.m. | Ok issued to Crawford – Dive in front of Units 1, 2, 3 from 9:00 a.m. to 12:00 p.m |
| 10:45 a.m. | Senior Operator called by dive tender that bubbles from divers could not be located |
| 10:50 a.m. | Senior Operator attempts a call to SLFD Health & Safety Officer, but no answer |
| 11:30 a.m. | POC notified about the divers and request permission to vane down Unit 5 to minimum flow |
| 11:31 a.m. | Unit 5 flow decreased |
| 11:49 a.m. | Plant Operator calls Senior Operator to shut down Unit 5 per SLFD Chief |
| 11:50 a.m. | Unit 5 shut down |

DWR DIVE TEAM

BACKGROUND

The DWR dive team was established in 1960. The team is divided into three divisions: Southern Field Division (SFD), San Luis Field Division (SLFD) and Delta Field Division (DFD). The dive team is part of DWR's Division of Operations and Maintenance. Any DWR employee can become a member of the dive team subject to certification as a diver and approval of DWR's Dive Safety Board. DWR dive team members include maintenance workers, scientists and engineers. Their dive responsibilities are voluntary and are in addition to their normal work assignments. At the time of the accident the team had 13 divers.

The DWR Dive Team follows policies and procedures required by the California Occupational Health and Safety Agency (Cal/OSHA). In addition, DWR has its own policies and procedures which are embodied in the Project O&M Instruction No. ST-9 (ST-9). ST-9 has the descriptions of the DWR Dive Safety Board, DWR Dive Team, dive coordinator, dive supervisor and dive tender. (Cal/OSHA and the ST-9 policies are attached as Exhibit A and Exhibit B.) The Cal/OSHA regulations were last updated in 1986. ST-9 was updated in 1998.

The following information is taken from DWR's ST-9 Manual. DWR has a Dive Safety Board whose members are appointed by the Chief of DWR's Division of Operations and Maintenance (O&M). The board includes four qualified DWR divers, DWR's Chief Safety Engineer and the Chief, Civil Maintenance Branch of O&M. The board's primary responsibilities include diver and dive tender training and safety programs, reviewing diving procedures and practices, reviewing dive equipment for adequacy and safety and approving diving equipment purchases. The board meets at least twice a year.

Each field division dive team has a dive coordinator. This coordinator must have a detailed knowledge of all dive regulations and be thoroughly familiar with basic diving techniques. If the coordinator is a qualified DWR diver, he/she may also be appointed to act as the dive supervisor. The coordinator must review all proposed dives, schedule the dives and coordinate the necessary outages and clearances, arrange for required divers, assemble personnel and equipment, and insure dive equipment is inspected and tested as required.

Each field division dive team has a dive supervisor who is a member of that division's team. He/she is appointed by the Dive Safety Board to plan and direct diving activities for that unit/division. The dive supervisor is in charge of all aspects of the diving operation and must be at the dive site during all diving activities. He/she evaluates the physical fitness and qualifications of divers and selects the divers for each dive; inspects all equipment for each dive; ensuring that everyone involved in the dive is thoroughly briefed on purpose of the dive and they know and understand all applicable safety regulations and emergency procedures; and debriefs divers immediately

following the dive. The dive supervisor assists the dive coordinator in obtaining the necessary work clearances for the dive. He/she has final authority and responsibility for the dive and may take any precautions necessary to ensure diver safety.

At each dive, there will be a tender-timekeeper (dive tender). The dive tender is either a qualified DWR diver or an individual approved by the Board as having the required background and training. The tender is responsible for recording the dive times, assisting divers in preparing and assembling the dive gear, helping the divers in and out of the water, and giving CPR and First Aid should the need arise.

The entire DWR Dive Team meets twice a year. At these meetings, the team reviews and discusses safety issues, including any near misses; policy and regulation; any equipment recalls; training among other relevant topics. Each year, one of these meetings includes an Advanced Scuba Diver Re-certification Training Course at Scripps Institution of Oceanography, in addition to discussion and review of the issues outlined above. During this re-certification, the dive team members dive under various conditions and physical skill requirements under the direction of dive instructors from Scripps. During the last Advanced Scuba Diver Re-certification course in late September 2006, the team received hands-on training and certification on new communication (com) gear. (Training agenda and minutes attached as Exhibit D. Sample re-certification confirmation letter is in Exhibit E.)

THE DIVERS INVOLVED IN FEBRUARY 7, 2007 ACCIDENT

Tim Crawford had more than 20 years experience as a diver. Crawford had been a member of the DWR dive team for over 18 years. At the time of the accident, Crawford was the both the Dive Coordinator and the Dive Supervisor for the SLFD Dive Team. Crawford last attended the Advanced Scuba Diver Re-certification Training Course in September 2006 with the DWR Dive Team (Exhibit D). Crawford was a utility crafts worker.

Martin Alvarado became a certified diver in September 2006. (Exhibit F) He participated in his first dive for DWR on October 10, 2006. (Exhibit H) At the time of the accident, Alvarado had completed 19 dives on behalf of DWR, the majority of which were done with Crawford. The dives in which Alvarado and Crawford participated together generally involved routine dives to inspect and conduct minor repairs at the pumping plant and along the aqueduct. As recently as November 28, 2006, Alvarado and Crawford participated in a dive at the DAPP where they inspected the trashracks for all six units. Alvarado attended the Advanced Scuba Diver Re-certification Training Course in late September 2006 with the DWR Dive Team. (Exhibit D) Alvarado was a utility crafts worker.

The diver who recovered Alvarado and Crawford's bodies is the Security Officer and Health and Safety Officer for the SLFD. He has been a member of the DWR dive team for more than 12 years and had dived many times with Crawford. He is the chairman of

the DWR Dive Safety Board and a Dive Supervisor for the SLFD. Safety Officer attended the Advanced Scuba Diver Re-certification Training Course in September 2006 with the DWR Dive Team. (Exhibit D)

Attached are copies of all dive reports from SLFD for dives in which Tim Crawford and/or Martin Alvarado participated. (Exhibit I) Also attached is the CPR/First Aid Training record for the Dive Tender. (Exhibit J)

DIVE EQUIPMENT AND TESTING

The divers' equipment was inspected on February 20, 2007 at the Los Banos CHP Station in the presence of CHP Officer Bill Bowers and Sergeant Michael Hagerman, Robert Pike Cal/OSHA engineer, DWR Team Leader David Gutierrez and Team Diving Consultant Joel Sturm and Safety Officer Kirk McBride. Joel Sturm cataloged and photographed the equipment as follows:

Diver 1 – Tim Crawford
Diver 2 – Martin Alvarado
(Exhibit K)

Dive Equipment Observed at CHP:

- Regulator – two stage, single hose, open circuit
- Buoyancy Compensator (BC) with Air2, Safe Second Regulator
- Console: Submersible Pressure Gauge, Depth Gauge, Compass
- Mask, fins, gloves, hood
- Knife mounted on BC - Diver 1; no knife discovered – Diver 2
- No lights recovered
- Dry Suit
 - Undergarment and socks
 - Dry suit boots
- Weight System
 - Shoulder and belt harness
 - Weights in pockets
 - Quick release system
- Diver to Diver Tether
 - 4-foot-long +/- 9mm braided nylon rope
 - Standard clip on one end (attached to BC of Diver 1)
 - Loop on other end (believed to be attached to wrist of Diver 2)

The following comments were based on visual inspection of equipment by Joel Sturm at the CHP Station on February 20, 2007.

- 1) Dry suits cut by rescue crew but in otherwise complete and in satisfactory condition
- 2) Diver 1: pockets of dry suit empty
- 3) Diver 1: equipment well used
- 4) Diver 2: equipment nearly new

Equipment observations (continued)

- 5) Diver 2: straps of weight harness cut by rescue crew
- 6) Both Divers: no indication that quick releases had been touched
- 7) Both Divers: BCs empty (deflated) when inspected on 2/20/07
- 8) Both Divers: max depth indicators of depth gauges pointed to a depth of 35 feet. This could be depth of a previous dive for diver 1 or an approximate measurement of this dive. This was the first use of this equipment for diver 2.
- 9) Air compressor viewed at SLFD on 2/9/07 (specifically intended for filling SCUBA cylinders).
- 10) Diver 2 equipment purchased on. (See listed receipt attached).
- 11) Air compressor purchased on 3/12/02, copy attached. Note: Compressor air tested 4/27/06, copy attached.
- 12) Annual BC Service 1/26/07, copy attached.

Also included in this review were pictures taken two days after the accident.

Equipment Viewed on 2/9/07 at SLFD (Exhibit L)

- Communications System
 - A full-face, hard-wire, surface-to-diver communication system was available in the dive van, but was not used.
- Air Compressor
 - Portable air compressor with filter carried in dive van and used to fill divers' air cylinders.
 -

Standard equipment not discovered

- No watches or time-keeping dive computer
- Flashlights

Testing of Equipment

Cal/OSHA sent the dive equipment to the United States Navy Testing Center in Florida in April 2007. Tests of the air in the tanks show the air to be of good quality. As of the date of this report, the Navy has not completed a written report for the testing of the equipment. However, the Navy discussed the equipment functionality/failure testing with DWR on December 10, 2007. The Navy said that all tests indicate that the equipment was properly functioning and did not appear to contribute to the demise of the divers. The Navy will complete the written report and supply it to DWR. Therefore, DWR will complete this Final Review Report and insert the Navy Report into the appendix at a later date.

SUMMARY OF FIELD TESTS

Excessive velocities, potential entanglement hazards and low visibility could have had an impact on divers at this site. Therefore, field tests and interviews were conducted to develop an understanding of these possible factors. Although the exact amount of debris that existed during the accident cannot be known with certainty, velocity testing and sonar and underwater camera inspections were conducted to determine the possible velocities and conditions within the aqueduct at the time of the accident. As part of this investigation, field tests were conducted on February 21 and 22, 2007 by attempting to replicate the conditions of February 7, 2007. (Exhibit O)

Water weed transported through the aqueduct causes significant plugging of the trashracks of operating units. Debris accumulates throughout the full height of the trashracks of operating units. When a pump is turned off, a significant reverse flow is experienced upstream from the trash rack, causing accumulated water weed and other material to flush off the trash rack. The trashracks remain clean and free of debris as long as the pump remains off. As seen in the photos in the report, trashracks that are not in use are essentially free of debris due to the reverse flow during pump shut off.

As soon as a pump is turned on, water weed and other debris are immediately drawn to that trash rack in front of the pump. As noted in the underwater video, the trashracks at Unit 5 were severely plugged by water weed during the test. When only one pump is operating, the debris build-up is more severe since all of the debris in the aqueduct is drawn to the only operating unit.

WATER VELOCITIES

Water velocities could have a significant effect on divers. As part of the accident investigation, tests were conducted under conditions simulating those at the time of the accident to get an understanding of how this could affect the divers. Water velocities at or near the trashracks are directly proportional to the amount of flow drawn by a pump and the debris accumulated. As the area that the water needs to pass through gets smaller due to debris clogging, the velocity increases, given the same flow. The tests revealed the water velocities in all directions near Units 1, 2 and 3 are very low during operating conditions similar to those on February 7, 2007. Since the units are off, velocities toward the plant are essentially zero in front of Units 1, 2 and 3. The maximum velocity measured at these units was only 0.2 ft/sec. This velocity is considered insignificant with respect to a diver's ability to swim against it.

Velocity measurements taken at Unit 4 indicate flow towards Unit 5 increases, but velocities still remain small, with the highest value measured at 0.64 ft/sec.

Therefore, the velocities in front of Units 1, 2, 3 and most of Unit 4 were not very high and divers would not have been overcome by these levels of velocities. However, the water could have caused the divers to unknowingly float towards Unit 5, particularly if

they were off the trashracks and unable to see the plant structure, their only point of reference.

The velocities became significantly higher in the area between Units 4 and 5 and in front of Unit 5.

Velocity measurements taken at Unit 5 could only be determined as close as two feet due to the equipment and boom truck capabilities. These tests indicate there is essentially no flow on the bottom eight feet of the aqueduct. This, in conjunction with the severe plugging of the trashracks from water weed, results in significant velocities in front of Unit 5 since the area of flow is greatly reduced. Although the highest measured velocity was 5 ft/sec into the trashracks, the water velocities at the trashrack face will be much higher. It is also expected that the velocities are different within different “holes” on the racks, as shown in the report. These conditions could cause a diver to become pinned against the trashrack and unable to move.

During the test, a differential head of 4.5 feet was measured between the water surfaces just upstream and downstream of the trashrack of the operating Unit 5. This is a result of the significant plugging of debris and water weeds. This differential pressure also exerts a significant force on a diver near the trashrack.

Operation of a remotely operated vehicle (ROV) during the field tests on February 21 and 22, 2007 also gives insight into the pressures associated with a severely plugged trashrack. During the test, the ROV easily maneuvered in front of the non-operating units. However, the ROV had difficulty maneuvering within two feet of the trashrack of Unit 5. The ROV lodged up against the Unit 5 trashrack twice during the test. In the first instance, Unit 5 had to be shut down in order to free the ROV. In the second instance, four men had to pull the ROV off the trashrack.

ENTANGLEMENT

The underwater investigation revealed there were no heavy entanglement hazards (trees, cars, etc.) for at least 200 feet in front of the trashracks at the time of the investigation.

VISIBILITY IN WATER

Divers familiar with the California Aqueduct estimate the divers' visibility at approximately one to two feet using standard diving flashlights. This is consistent with the estimate of the Safety Officer who was the recovery diver on February 7, 2007. The ROV had a visibility of approximately two to three feet. However, the lighting on the ROV is significantly brighter than that of a typical diver's flashlight.

SUMMARY OF CHP AND CAL/OSHA ACCIDENT REPORTS

CHP INVESTIGATION AND REPORT

The CHP Los Banos Division issued an investigative report on July 7, 2007. The report was prepared by Officer Bill Bowers Jr. who arrived at the accident scene on February 7, 2007 at 1244 hours. Officer Bowers took the dive gear of both divers from the scene to the CHP office. The report includes a chain of custody report on that equipment.

Officer Bowers conducted interviews between February 9, 2007 and June 14, 2007 that included DWR staff, the wives of Alvarado and Crawford, and Robert Pike, the Cal/OSHA investigator assigned to the accident. Officer Bower concludes that there was no evidence of any criminal activity on the part of another person or persons that caused the death of the two divers and the cause of their deaths is undetermined. (Exhibit Q).

Ca/OSHA SUMMARY AND REPORT

Ca/OSHA staff conducted an independent investigation. (Exhibit R)

Ca/OSHA identified deficiencies in DWR's dive program. On August 7, 2007, DWR was given citations of general and serious violations and a special order was issued. . Ca/OSHA cited DWR for the following:

1. Failure to have an alarm monitor on the high pressure breathing air compressor unit;
2. Failure to keep detailed written records of maintenance of regulators, buoyancy compensators and other gauges.
3. Failure to have all pumps shut off during dive operations;
4. Failure to limit water velocities to less than one knot during SCUBA diving operations;
5. Failure to have written emergency procedures in the DWR Dive Manual and failure to include planning for emergency procedures for the February 7, 2007 dive;
6. Failure to provide training and instruction to the dive tender.

Citations 1 through 4 are general citations. Citations 5 and 6 are serious. Cal/OSHA issued penalty fines to DWR totaling \$15,370.

Included with the citations, Cal/OSHA issued a Special Order requiring DWR to take the following actions by August 21, 2007 or prior to any future dives by DWR employees:

1. Complete this investigation and report of the accident;
2. Implement applicable portions of the U.S. Department of the Interior Bureau of Reclamation Diving Safe Practices Manual;
3. Implement use of voice communication for all dives;
4. Implement positive means of location, emergency, retrieval and rescue procedures; Implement use of Remote Operated Vehicle (ROV) for underwater inspection and observation where deemed necessary.

(A complete copy of the citation is included in Exhibit S.)

CONTRIBUTORY /CAUSAL FACTORS AND TEAM FINDINGS

In following the CDF accident investigation program and format, the DWR team included contributory and causal factors as listed below, as well as stated findings from its investigation.

CONTRIBUTORY FACTORS

Definition: A contributory factor affects the occurrence or outcome but was not causal. Avoiding or eliminating would not necessarily prevent the occurrence.

- Unit 5 was operating.
- The water in the aqueduct was of low visibility.
- An adequate dive safety plan was not discussed between the dive tender and divers, nor was the details of the sequence/procedure the divers would follow for the inspections.
- The dive tender was not properly trained (first time served as a tender) and did not have adequate knowledge of diving policies or procedures.
- Underwater communication equipment was not used.
- The original dive plan was not followed with regards to divers and dive tenders. The dive tender was substituted on the morning of the dive.
- The divers may not have believed or considered that there was a possibility they could inadvertently enter an area of “excessive” velocities.
- A surface to diver tether was not used.
- The trashrack cleaning system which normally keeps the trashracks clean of debris was not operational. The resulting clogging at Unit 5 trashrack may have resulted in significant differential pressures and increased velocities on February 7, 2007.
- There was unclear authority by staff as to who can shut down the unit once the emergency was identified.
- The dive supervisor did not have authority over divers’ or dive tenders’ routine schedules to avoid substitutions.
- Lack of sufficient knowledge by plant operators of diving policies/procedures.

- The divers were tethered together.
- New/borrowed dive equipment was used by one of the divers.

CAUSAL FACTORS

A causal factor is any behavior, condition, act, or omission that starts or sustains an accident occurrence. Avoiding or eliminating would prevent the occurrence.

We conclude no one factor caused the accident and we may never know exactly what led to the death of the divers. However, it is clear that there were many contributory factors and that the current dive policies and practices in place are not adequate.

FINDINGS

Human Behavior

- Senior diver Crawford had significant diving experience.
- Alvarado was a relatively new diver for DWR.
- This was the Dive Tender's first assignment as a dive tender.
- On the morning of February 7, 2007, dive coordinator and supervisor Crawford substituted the dive tender and agreed to reduce the number of divers from three to two.
- Prior to the dive, Crawford completed out and signed the final dive report.
- The two divers and dive tender met and talked in the parking lot of the Dos Amigos Pumping plant on the morning of February 7, 2007.
- There was no discussion as to the sequence/procedure the divers would follow for the inspection or the expected length of time the divers would be underwater, available air supply, or a plan of action if the divers did not surface.
- DWR's dive policy states: "Diving is prohibited wherever there is a possibility the divers may inadvertently enter an area of excessive water velocity." This policy may not have been followed OR the divers did not believe there was a risk of excessive velocities by Unit 5 OR the divers did not believe they could inadvertently end up in front of Unit 5.
- By all accounts, both divers were healthy.

- The divers entered the water at about 1015 hours on February 7, 2007.
- Observing from the deck, the Dive Tender followed the divers' bubbles moving at a steady rate in an approximately straight line from Unit 1, 2, 3 and 4 with no apparent stops or changes in direction. He observed there were two distinct bubble patterns.
- The Dive Tender requested assistance from the operators at 1045 hours to search for the divers' bubbles.
- The divers did not release their weight belts.
- The divers were recovered in front of Unit 5.
- The two divers were pronounced dead at the hospital.
- The coroners report has not been released but advance information indicates that the specific cause of death was drowning.

Equipment

- The divers used SCUBA gear to perform the inspection dive.
- The dive equipment was in satisfactory condition and the air in the divers' tanks was satisfactory, per verbal communication with the U. S. Navy.
- The equipment used by Alvarado was new and being used for the first time, except the weight belt which belonged to another diver.

Note: The U. S. Navy testing division still has custody of the dive equipment. The test of the equipment has just been completed and the Navy has verbally reported that it is functioning properly. However, a written report has not yet been sent to DWR. Once it has been received by DWR, it will be included in the appendix.

Site Conditions

- Unit 5 (of six units) was operating at 100 percent (2700 cfs) during the dive. Units 1, 2, 3, 4, and 6 were not operating at the time of the dive.
- Unit 5 flows were reduced to 50 percent at 1130 hours and the unit was shut down at 1150 hours.
- The trashrack at Unit 5 was likely clogged with debris causing excessive velocities and high differential pressures directly in front of Unit 5, based on

velocity measurements and testing conducted under similar operating conditions on February 21 and 22, 2007. Severe plugging occurs when only one unit is operating since all the debris is drawn to the only operating unit.

- The sweeping velocities in front of Units 1 to 3 were low and considered insignificant compared to a diver's ability to swim against the flow, based on tests conducted February 21 and 22, 2007 (.2 ft per second).
- Diver visibility in the water of the aqueduct was about one to two feet with the equipment generally used by the divers, although flashlights were not recovered.
- There appeared to be insignificant entanglement hazards based on tests conducted two weeks later, simulating the conditions at the time of the accident.
- The amount of fishing line found on Alvarado's leg was small and unlikely to have caused problems for a diver.

Communications

- The surface to diver communication system was not used for this dive.
- The Dive Tender was instructed by the dive supervisor to bang on the trashracks if he needed to communicate with the divers.
- Crawford and the Plant Operator discussed pump operations in the ACC prior to the dive. The operator indicated that Unit 5 was the only pump operating. The Dive Supervisor told the operator to notify the Dive Tender if pumping operations were to change during the dive, so the divers could exit the water.

The Dive Tender contacted the Senior Operator at 1045 hours by cell phone for assistance. The SLFD Chief Engineer contacted the Field Division Chief at approximately 1114 hours. The SLFD chief engineer made contact with Safety Officer at 1119 hours by phone.

Situational Awareness

- The divers and Dive Tender were aware that Units 1, 2, 3, 4 and 6 were off and that Unit 5 was running at full capacity during the dive.
- The Dive Tender lost sight of the divers' bubbles at approximately 1035 hours.
- It is unknown whether the divers were aware of the potential for high velocities as a result of trashrack plugging.

POSSIBLE UNDERWATER SEQUENCE OF EVENTS PREPARED BY THE BOARD OF REVIEW⁵⁶

After reviewing the draft report prepared by the Investigative team, the members of the Board of Review drafted a possible underwater scenario.

Below is their summary:

From the time the divers entered the water at approximately 10:15 until they were recovered in front of Unit 5, only their path of travel from Unit 1 to Unit 5 was observed by others and is the only action on their part that can be considered certain. The reason for them proceeding directly toward Unit 5 is not known, nor do we know for certain if the direct cause of death occurred at the trashrack in front of Unit 5 or on the way to the unit. We can only theorize as to what may have transpired once the divers submerged. Based on observations made the day of the incident, collected data, and input from other divers and others participating in this investigation several possible explanations are offered below.

The possibility of the divers becoming unconscious prior to reaching Unit 5 was considered but, unless testing indicates a serious equipment malfunction, that scenario is not likely, for several reasons:

- 1. The divers' bubbles were observed in an apparently continuous, direct line along the face of the structure. Had the divers been rendered unconscious prior to reaching Unit 4, the negligible current towards Unit 5 would likely have resulted in them remaining in place or taking longer than observed to reach Unit 5.*
- 2. If the divers became unconscious while still in front of Units 1, 2, or 3, the bubble pattern likely would not have remained relatively constant, as was observed. The bubbles may have stopped or, if the regulator(s) began free-flowing, the bubbles may have appeared differently.*
- 3. Testing of the air in the tanks indicates it was normal, ruling out the possibility that both were rendered unconscious simultaneously and relatively quickly before they could recognize a problem and react to it.*
- 4. Had one or even both divers experienced distress, they should have been able to surface, since there were no apparent obstacles to prevent it. Some debris was observed at the surface but the February 21-22 test indicates the trashracks at non-operating units are relatively clean and there was no evidence of debris large enough to snag them (e.g. tree branch). Also, the sweeping velocity was practically zero in front of Units 1, 2 and 3. If necessary, a diver could also have added air to his buoyancy compensator, to increase the rate of ascent. At Unit 4*

⁵⁶ The Board of Review is comprised of four members (independent of the investigative team) who reviewed the draft Investigative Report and provided the following scenario. Further description of the Board can be found in the beginning of the report.

subsequent testing indicates the horizontal sweeping velocity increases to about 0.6 feet per second, which a diver could resist as he ascended vertically, provided he was aware the current was pulling him towards Unit 5.

5. *It is unusual for both divers to perish in a relatively shallow dive such as this one without experiencing serious equipment malfunctions and without other external hazards (as were apparently absent at Units 1, 2 and 3). If one diver becomes seriously distressed, such as running out of air, the other is able to render assistance and both typically can ascend to the surface without problem. If he is unable to render assistance, the diver would ascend to get help before he also perishes. Although the divers were tethered in this case, it should not have been a problem to remove the tether from Mr. Alvarado's wrist or unclip it from Mr. Crawford's gear.*

The divers did not discuss the underwater logistics of the dive with the dive tender, nor were they heard by others discussing the sequence/procedure they were going to follow in inspecting the trashracks and concrete surfaces at Units 1, 2 and 3. Since the bubbles were observed in an apparently continuous, direct line along the face of the structure, and since testing confirmed the sweeping velocities in front of Units 1, 2 and 3 were zero or negligible, it appears the path of travel was a conscious decision at least until they reached Unit 3.

The divers apparently decided to inspect a horizontal strip across Units 1, 2, and 3 first and then proceeded beyond Unit 3 possibly because they lost track of their location, or possibly decided to inspect Unit 4 as well, or they may have inadvertently drifted beyond their intended limit. Mr. Alvarado was using new equipment, taken out of the box prior to the dive, and resurfaced once to adjust his mask, which was leaking. It is possible that, as they inspected the end of Unit 3, another adjustment to his equipment became necessary, most likely to his regulator or Air II, and engaged both divers to the point they drifted, without realizing it, beyond their intended limit and into Unit 5. Another possibility is that, having reached the end of Unit 3, the divers began their ascent at Unit 4 and, without realizing it, were gradually pulled towards Unit 5 by the increasing sweeping velocity. Unless the divers were in contact with the bottom or were closer than 2 to 3 feet from the face of the structure (the probable limit of visibility), they would lose all points of reference and could have drifted in the gentle but increasing current without realizing it.

Upon reaching Unit 5 the high velocities likely pinned them to the trashrack, where they either exhausted their air supply or their regulators were pulled from their mouths and free-flowed until the air was depleted. With the degree of clogging observed throughout the depth of Unit 5 at the February 21-22 test, the velocities at the scattered, unclogged "windows" were measured as high as 5 feet per second at a distance of 22 inches from the surface, meaning the velocities at the trashrack surface were likely twice that or more. These localized areas of high velocity produce a force sufficient to pin a diver to the surface and render him unable to extricate himself, especially if he were pinned with his back against the surface. During the February 21-22 test, the ROV became pinned

to the trashrack and four men pulling on the umbilical could not pull it free; Unit 5 had to be shut down in order to free it.

Thus, it appears that the divers were conscious when they reached Unit 3 and, for reasons not known, continued to swim or drifted towards Unit 5, where strong velocities and differential pressure pinned them to the trashrack until the unit was shut off.

SERIOUS ACCIDENT/INVESTIGATION PROCESS

On February 8, 2007, DWR Chief Deputy Director Nancy Saracino directed Assistant Director Dave Gutierrez to lead an investigation into the circumstances surrounding the deaths of two DWR employees at the Dos Amigos Pumping Plant the previous day. The California Department of Forestry and Fire Protection's (CDF) Serious Incident Services unit had already begun assisting DWR in providing counseling services to DWR staff the SLFD offices. Saracino also indicated that Crawford Tuttle, CDF Chief Deputy Director offered investigation assistance.

At 1500 hours, Gutierrez assembled the potential team members for a conference call. The purpose of the conference was to determine areas of expertise and potential levels of participation in the investigation. The conference participants included:

Potential Team Members

| | |
|-----------------|------------------------------|
| Michelle Morrow | DWR |
| Karen Joelson | DWR |
| Joel Sturm | USBR |
| Nelson Ross | USBR |
| Patrick Prince | Private Consultant/Counselor |

Other Conference Call Participants

| | |
|---------------------|------|
| Elizabeth Partridge | USBR |
| Linda Rowley | USBR |
| Carl Torgersen | DWR |
| Ralph Torres | DWR |

Carl Torgersen gave a preliminary briefing of the accident during the conference call.

At 1700 hours, Gutierrez met with Saracino, Chief Counsel David Sandino, and staff counsels Karen Joelson and Michelle Morrow. During this meeting, Gutierrez requested minor adjustments to the team and requested CDF assistance for the investigation. Gutierrez was put in contact with CDF Southern Region Chief Candace Gregory for assistance. Chief Gregory assigned Unit Chief Mikel Martin and Fire Captain Kirk McBride to assist with the investigation. Gutierrez later contacted Greg Rowsey, Chief of the DWR Personnel Office, to assist in the investigation. The final team members are referenced in Table 1.

Table 1

| Team Member | Agency | Assignment |
|-----------------|--------|--|
| David Gutierrez | DWR | Team Leader |
| Mikel Martin | CDF | Consultant to Team Leader |
| Karen Joelson | DWR | Investigator - Interviewer |
| Michelle Morrow | DWR | Investigator - Liaison with outside agencies |
| Kirk McBride | CDF | Consultant to DWR Safety Officer |
| Greg Rowsey | DWR | Staff Support |
| Joel Sturm | USBR | Investigator – Diving Consultant |

On February 9, 2007, an initial team meeting was held at 0900 hrs at the San Luis Field Division headquarters to discuss team member roles and responsibilities, confidentiality requirements, priority tasks and required reports

The team met on April 12, 2007 to review the information and data collected up to that point. The team again met on May 7, 2007 to review and edit a draft of the report.

The information used in assembling this report was collected through a variety of processes including witness interviews, photographs, records, historical data, surveillance video, telephone records, underwater video, equipment and field testing reports.

As needed, specialists were relied upon to assist the team's investigation. This included underwater photography, water velocity measurements and dive equipment analysis.

CHP collected the dive equipment recovered from the accident. They established a chain of custody for the equipment. Reports conducted by CHP, California Occupational Health Services (Cal/OSHA), and the Coroners Office were also relied upon in this report.

DIVE EQUIPMENT TESTING

In April 2007, the dive equipment used on February 7, 2007 was sent to the U. S. Navy Testing Center in Florida for advanced testing. The Navy has tested the air in the tanks and concluded it to be of good quality. The Navy has not yet released a written report,

but has verbally indicated all the equipment tested was properly functioning. DWR has chosen to complete this report and will incorporate the Navy's final written report into the appendix when it is completed.

BOARD OF REVIEW

A separate Board of Review, comprised of two representatives from DWR, one representative from CDF, and one representative from the U.S. Bureau of Reclamation, convened on August 16, 2007. The Board reviewed the DWR report and supplemental information and made changes, corrections, and recommendations. The Board of Review members are referenced in Table 2.

Table 2

| Board Member | Agency | Position |
|-----------------|--------|---|
| Tom Beiler | DWR | Health & Safety Manager, Personnel Services Division |
| Cosme Diaz | DWR | Supervising Civil Engineer, Division of Engineering, Former DWR Dive Team member |
| Candace Gregory | CDF | Region Chief, Southern Region |
| Rodney L. Tang | USBR | Civil Engineer, Design Branch, Phoenix Area Office, Current USBR Dive Team member |

PRELIMINARY REPORT

A Preliminary Summary Report with initial findings on the accident was completed on February 16, 2007 (Attachment 2) and distributed to DWR employees and other interested parties.

INDEPENDENT DIVE SAFETY CONSULTANT COMMITTEE

On March 22, 2007, DWR Director Snow named an independent expert consultant committee to review the safety of DWR's dive program and make recommendations based on their review of the current policy, industry standards and applicable regulations. The panel did not investigate the February 7, 2007 dive accident as part of their review. Their report was issued on August 14, 2007. A copy of the final report is included in Attachment 4 to this report.

DWR suspended its dive program immediately following the February 7, 2007 accident pending the outcome of the investigations and review/development of a DWR dive program consistent with state and federal guidelines and model industry programs.

Glossary of Terms for Report

Acoustic profiler: See U. S. Bureau of Reclamation Report

Aqueduct: An artificial channel for conducting water from a distance, usually by means of gravity.

Area Control Center: Dos Amigos Pumping Plant local operations control system location/operator station located on the 3rd level at the west end.

Area Control Center Log: Operator entered log at all known events occurring during each shift.

Buoyancy compensator vest: A deflatable/inflatable vest which is designed for the attachment of several diving related components (tank, hoses, secondary breathing regulator, depth gage, etc.), and also which enables a diver to control descent/ascent and maintain neutral buoyancy when desired.

Cal/OSHA: The California Occupational Safety and Health Agency. The Cal/OSHA Program is responsible for enforcing California laws and regulations pertaining to workplace safety and health and for providing assistance to employers and workers about workplace safety and health issues.

Communication gear: Equipment used by divers to communicate between the diver and the individuals, or tenders, on the surface.

Dive Tender: A tender-timekeeper (sometimes called a tender) shall be a qualified DWR diver or other individual approved by the Board as having the required background and training. A tender's responsibilities include: recording the dive times and related information, assisting the divers to prepare and disassemble the dive gear, helping the divers into and out of the water, and giving CPR and First Aid, should the need arise.

Doble Testing: An electrical preventive maintenance test for verifying the condition of a high voltage transformer.

Fire hoe: A long handled tool with a steel hoe type working implement at the end.

Forebay: The upstream body of water, in this case the upstream canal from which the pumps draw water by suction.

Forebay invert: The bottom surface of the forebay/canal.

Free flow: the uncontrolled release of pressurized air through a diving regulator, usually in a high-volume stream, that sometimes occurs when the mouthpiece is removed from a diver's mouth or when the purge valve is accidentally depressed.

Grates: The steel framed steel bars which make up the trash rack.

Heavy equipment: A large construction type vehicle which was used in the recovery. This was an excavator.

Hydro-electric Plant operator (HEP Operator): A journey level State civil service classification.

Mouth piece: A soft piece of rubber attached to the regulator, which a diver places into his mouth to take in air.

Notice of Dive: Form DWR 3569 used to notify the Chairperson of a routine dive or used to request approval for a non-routine dive. Requests for dives on project facilities should also be submitted to the Operations Supervisor at the appropriate ACC for outage requests.

Regulator: The device that is connected by a hose to the high pressure dive tank primary regulator which further reduces the breathing air pressure for delivery to the diver through a mouthpiece.

Routine Dive: - A dive is classified as routine if it satisfies all the following criteria:

1. Diving operations will be conducted in conformance with provisions of Section G of OEM Instruction ST-9.
2. Safety regulations to be implemented will conform with provisions of Section H of O&M Instruction ST-9.
3. Dive depth will not exceed 35 feet..
4. All diving will be conducted in open areas. Any lateral or horizontal dives where divers must enter pipes, tunnels; or other enclosures where there is no vertical ascent are considered non-routine.
5. Diving is restricted to bodies of open water where flow velocities are not so excessive as to cause a diver to become fatigued. Diving is prohibited wherever there is a possibility the divers may inadvertently enter an area of excessive velocity.
6. Wind and water surface conditions are relatively calm.
7. The standard Notice of Dive form (DWR 3569), complete with all pertinent information, is sent by FAX machine to the Chairperson sufficiently in advance of all proposed dives.

Non-routine dive: A dive is classified as non-routine if it fails to meet any of the requirements for a routine dive. Diving activities must be authorized by the Chairperson (or his/her designee in his/her absence) prior to diving activities.

Sonar: A method for detecting and locating objects submerged in water by echolocation.

ST-9: Project O&M Instruction No. ST-9, Diving Policy for Department of Water Resources Dive Team.

Sump pump pipe: A small diameter pipe that transports water being transferred from one location to another through means by a sump pump (usually a small electric motor driven pump).

Tether (to each other): A line or rope used to keep divers close to each other normally used in low visibility conditions.

Tether to surface: A line or rope from a secure surface location to a diver. It could also be part of a reinforced communication line which connects from a diver's gear/communication device to a surface communication device.

Transformer: A large electrical apparatus for reducing a higher voltage (230KV) to a lower working voltage. (13.8KV).

Trashracks: Evenly spaced steel framed bars which prevent larger debris from entering a pump unit intake.

Turbulence: 1. The quality or state of being turbulent; violent disorder or commotion; 2. Hydraulics. The haphazard secondary motion caused by eddies within a moving fluid.

Unit: Pump and all of its components are often referred to as a unit.

Velocity: Rapidity of motion or operation; swiftness; speed: a high wind velocity.

Velocimeter: A device that utilizes the Doppler effect to measure the speed of sound in water. Developed by the U.S. Army Corps of Engineers, a velocimeter transmits a pulse of sound through water and measures its echo for changes in either pitch or frequency. Oceanographers employ velocimeters to study the interior structure of breaking waves; they are also used in hydraulic engineering and to study fluid flow.

Water weed mat: Collection of water weed that eventually forms a mat.

Work Clearance Application: A procedural requirement necessary when a diver enters an area that requires a greater degree of protection; such as diving near a check site or in front of a pumping plant. It is a statement from the Operations Supervisor declaring that the equipment to be worked on has been de-energized and isolated from hazardous sources of energy and that is, in that respect, safe for the worker (or diver) to proceed with the work authorized.