# APPENDIX C

# ENGINEERING APPENDIX

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# Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System

This document provides criteria to be used in preparing the South Dade Conveyance System (SDCS)/Miami Dade County for forecasted storm events. The SDCS is composed of L-31N, L-31W, and C-111 canal system and control structures. Currently, for the East Coast Canal System, the canal system and control structures to the east of L-31N, the South Florida Water Management District (SFWMD) implements canal drawdown operations based on impending rainfall events. The goal for the SDCS is to implement a similar set of canal drawdown operating criteria which seek to balance the needs of the natural system with the authorized purposes of the Central and Southern Florida (C&SF) Project, which is multipurpose in scope and includes flood control and water supply.

The hurricane season is from June through November. When there are tropical depressions, tropical storms, and/or hurricanes in the Atlantic/Caribbean Basin, the National Hurricane Center (NHC) issue tropical cyclone public advisories, forecast advisories, forecast discussions, and strike probability forecasts* every 6 hours.

* {For the period 1989-1998, the average location error by forecast period was 55 statute miles at 12 hours, 102 miles at 24 hours, 147 miles at 36 hours, 164 miles at 48 hours and 278 miles at 72 hours. The strike probability forecast indicate the statistical chance that the tropical cyclone center will pass within 75 statue miles of a specified location within 3 days of the initial forecast time. The maximum strike forecast probabilities are 10-15% at 72 hours, 20-25% at 48 hours, 25-35% at 36 hours, 40-50% at 24 hours, an 75-85% at 12 hours.}

The SFWMD employs meteorologists who evaluate each tropical event and prepare average forecast errors using NHC forecast tracking maps. The average forecast error means when the Hydrometeorologic Prediction Center (HPC) or NHC has forecasted a specific track and the cyclone could end up anywhere in that “swath” within the next 72 hours with around a 60% confidence level. The average forecast error swath is based on the 10-year average of forecast errors.

The SFWMD Operations Control Division has defined operational procedures to be implemented depending on the timing or amount of advance warning prior to the onset of tropical storm force winds. The Corps of Engineers also has defined in the Master Water Control Manual for each part of the Central and Southern Florida Project (C&SF) a water control plan with instructions for pre-storm operations for structures around Lake Okeechobee and the Water Conservation Areas. The SFWMD operational procedures are termed “Conditions”, the specific operating procedures for these conditions will be described in further detail in this document. Conditions are briefly summarized as follows:

- Condition 4, 72 – 48 hours prior to the impact of tropical storm force winds, is earliest level of preparation when the system is evaluated and initial adjustments made to operations depending on the forecast and nature of the storm. Coordinate with the Corps of Engineers and local drainage districts
- Condition 3, 48 – 24 hours prior to the impact of tropical storm force winds, continue pre-storm operations and coordination with the Corps of Engineers and local drainage districts.
- Condition 2, 24-12 hours prior to the impact of tropical storm force winds, bring telemetry-controlled sites to final pre-storm configuration, establish alternate emergency control station if necessary.

The remaining levels of preparation are Condition 1, 12 – 0 hours prior to the impact of tropical storm force winds; during the event; and recovery after the event. It is important to note that some storm events do not allow for the full condition 4 with even 48 hours of advance warning.

It is important to emphasize that the Central and Southern Florida Project is multi-purpose in design, and that pre-storm operations may not prevent flooding, such as experienced after Hurricane Irene in October 1999 or the no name storm in October 2000. The condition of the groundwater system at the time of a storm event is significant and is highly dependent on the amount and extent of rainfall that has already occurred prior to subsequent events. Further, there are areas of Dade County, and South Florida in general, which are at low elevations and for which no amount of drawdown can prevent flooding depending on the amount and extent of the event. The water levels discussed in this document are target levels and may not be attainable.

During the Cape Sable seaside sparrow nesting season, March 1 through July 15, or until nesting success, as defined in the Fish and Wildlife Service February 19, 1999 Final Biological Opinion, has been met, pumping at S-332D and S-332 is limited to 165 cfs. This constraint on pumping may limit the ability to implement pre-storm operations. At this time, the USACE Hydrologic Investigation Section is preparing modeling to determine possible impacts to sparrow nesting or implementing pre-storm operations.

## Notification and Briefing Process

The Executive level will be briefed prior to initiation of pre-storm operations. This may occur prior to 72 hours or as soon as the average error forecast swath shows South Florida to be likely to be in the path of a storm. Obtaining Executive level approval is important in order to demonstrate to interested parties, such as the Fish and Wildlife Service and the National Park Service, that operations were not arbitrary or capricious and that possible impacts to the sparrow or to the natural system were considered;

however, in order to maintain the multi-purpose functioning of the C&SF project, flood control operations were necessary.

# 1. Conditions 4 and 3 (24 to 72 Hours Prior to Storm Conditions)

Based on the Executive level orders, up to 72 hours in advance of a storm.

## *Drawdown Implementation:*

Between 24 and 72 hours before tropical storm conditions in Miami-Dade, the following target water levels are set for the SDCS. The initiation of the pre-storm drawdown criteria will be triggered when Dade County is within the average error forecast swath as developed by the NHC. These pre-storm drawdown levels are not less than the level at which water supply deliveries are made during dry periods, that is 1.5 ft below optimum canal levels, except the reach north of G-211, which is 1.0 ft below current, normal operating levels. These levels are target levels and may not be attainable.

Table 1.

| Canal | Reach | Target Level for Draw-Down (ft) |
|---|---|---|
| L-31N | G-211 to S-331 | 4.0* |
| L-31N | S-331 to S-176 | 4.0 |
| L-31W | S-174 to S-175 | No target |
| C-111 | S-176 to S-177 | 3.0 |
| C-111 | S-177 to S-18C | 2.0 |
| C-111 | S-18C to S-197 | No change** |

*If Angel's well is 5.5 ft-NGVD or below, then 4.0 would be the target, otherwise, 3.5 ft-NGVD at the headwater of S-331 will be the target.

**Operation as specified in the SFWMD structure book for S-197

## *Sequence for Achieving Target Levels*

In an effort to achieve the specified drawdown targets, a sequence of operational actions is recommended as described in Table 2. The goal is achieve one target before proceeding the next sequence, however, it may not be possible to achieve the target level and operations will proceed as based on the best available information at the time:

Table 2.

| Sequence | Canal | Reach | Target Draw-Down Level (ft) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1 | L-31N | S-331 to S-176 | 4.0 |
| | C-111 | S-176 to S-177 | 3.0 |
| 2 | L-31N | G-211 to S-331 | 4.0* |
| | L-31N | S-335 to G-211 | 5.0 |

* If Angel's well is 5.5 ft-NGVD or below, then 4.0 would be the target, otherwise, 3.5 ft-NGVD at the headwater of S-331 will be the target.

## *S-332B*

Operational criteria are developed to meet the RPA requirements. The criteria takes into account pre-storm and storm operations, except emergency deviations that must always be dealt with on a case-by-case basis. S-332B is a part of the Central and Southern Florida (C&SF) Project, which is multipurpose in scope. While S-332B allows flexibility to operate the C&SF project to better meet the needs of the Cape Sable seaside sparrow it may also be used for meeting other project purposes such as flood control.

Table 3.

| **Rising Water Level (ft)** | **Discharge (cfs)** | **Falling Water Level (ft)** | **Rated Discharge (cfs)** |
|---|---|---|---|
| 4.7 | 75* | 5.0 | 450 |
| 4.9 | 200** | 4.9 | 325 |
| 5.0 | 325 | 4.8 | 200** |
| 5.1 | 450 | 4.7 | 75* |
| 5.2 | 575 | 4.2 | 0 |

* Start with 125-cfs pump if 75-cfs pump is not operational

** This will cause overflow of the weir in the retention area

During pre-storm operations, the criteria for operation of S-332B will be the same as under normal operations, however, the notification procedure is to take place prior to changes in the upstream or downstream structural operations. Refer to the notification and briefing process section of this document regarding briefing the Executive level prior to initiating pre-storm operations.

## *S-332C*

S-332C will be used in a similar manner as S-332B.

## *S-197*

No change is suggested in the operational criteria for this structure during Condition 4. The operational criteria is defined the SFWMD structure book for S-197.

## 2. Condition 2 and 1 (12 to 24 Hours Prior to Forecast arrival of tropical storm force winds).

Continue operations as in Condition 4 and 3, but with the following considerations:

Table 4.

| Structure | Status |
|---|---|
| S-331 | Secure. Do not operate during storm. |
| S-332B | Secure. Personnel move to S-332D office area during storm. |
| S-332D | Continue pumping. Office area is hardened. |
| S-175 | Keep closed |
| S-197 | Consideration to be given to open 3 gates |

### *S-332B*

Pumps are secured for safety reasons. Personnel should move to S-332D for protection from tropical storm force winds, and to await resumption of operations at S-332B.

### *S-332C*

S-332C will be used in a similar manner as S-332B.

### *S-197*

Operation of this structure requires mobilization of field personnel and equipment to operate the gates. It is not safe to operate this structure during storm conditions. Consequently, depending on conditions, three gates may be opened at Condition 1.

## 3. Recovery (Conditions immediately after the storm ends or if the storm forecast changes such that Dade County is no longer likely to be affected.)

Operations during Recovery consist of: 1) Maximizing discharges at water control structures to minimize flooding and 2) make the transition back to operational regime in place prior to the storm.

Operations may also be returned to levels prior to implementing pre-storm operations as soon as the Dade County is no longer within the average forecast error swath.

***Plan for Worst Case:*** Recovery will be necessary if storm conditions result in significant rainfall in the Miami-Dade County area. The target for operations would be to return to operational regime in place prior to the storm. However, use of water control structures (e.g., S-175, S-332B) under emergency flood control mode will begin or continue until Recovery is complete. The following operations are suggested to continue to operate in emergency flood control mode:

Table 5.

| Structure | Status |
|---|---|
| S-331 | Pump when downstream conditions allow |
| S-332D | Continue to pump |
| S-175 | Use of this structure would be on a case by case basis with concurrence from the Department of Interior. |
| S-197 | Open depending on conditions |
| S-332B | Resume pumping according to proposed operational criteria, weir may overflow |

### *Sequence for Achieving Normal Operating Ranges*

It is not possible to describe the sequence of operational actions during Recovery prior to a particular storm event. The sequence of operational actions will depend largely on the rainfall distribution and rainfall amounts resulting from the storm.

## 4. Back to Normal Mode (Operational regime in place prior to the storm)

The following conditions must be met before ceasing emergency flood control mode and resuming normal mode:

1. DOI will advise the Corps of any overflow problems or adverse impacts to the CSSS Subpopulation F that may be occurring for the Corps to use in their decision regarding pumping reductions at S-332B and S-332C.
2. Otherwise, stages in canal reaches must be within the specified operating ranges in place prior to the change in pre-storm or storm operations to resume normal mode.

Once these conditions are met, the normal mode, as defined by operational regime in place prior to the storm, may be resumed. Emergency use of certain water control structures, such as S-175, S-332B, and S-332C would cease.

This document may be modified depending on additional information, as it becomes available.

## Operations for other than named events

SFWMD will monitor antecedent conditions, groundwater levels, canal levels and rainfall. If these conditions indicate a strong likelihood of flooding, SFWMD will make a recommendation to the Corps to initiate pre-storm operations. The Corps will review the

data, advise ENP, FWS of the conditions, consult with the Miccosukee Tribe and make a decision whether to implement pre-storm drawdown or otherwise alter system wide operations from those contained in the table.

In addition, the Chairman of the Miccosukee Tribe of Indians of South Florida or his designated representatives, will monitor the conditions in WCA3A and other tribal lands and predicted rainfall. If the Tribe determines these conditions indicate jeopardy to the health or safety of the Tribe, the Chairman will make a recommendation to the Corps to change the operations of the S12 structures. The Corps will review the data, advise appropriate agencies of the conditions, and the District Commander will personally consult with the Chairman prior to making a decision whether to implement changes to the S12 operations.

# Summary of Pre-storm Operations
# June 2002 – October 2005

For each pre-storm operation, the proposal was discussed with the FWS and ENP and the overall status of the system assessed prior to any adjustment of structure criteria. The protocol of Appendix A was followed, unless there was an issue related to whether ENP preferred the use of C-111 over the exceeding a depth of 2 feet in the detention areas or visa versa. These actions included the opening S-176 prior to exceeding a depth of 2 feet in the detention areas, or turning on S-332D ahead of S-176 depending on the season. As soon as the event was over, the system was promptly returned to criteria prior to the storm advisory.

For 2002, issues related to private property adjacent to S-332B north reduced system capacity during a storm. And thus limited the operation of S-332B to only S-332B West and the maximum of 250 cfs.

The actual amount of rain that fell is not a valid assessment of a pre-storm operation. A water manager only has a forecast and system wide status to use in making a decision.

Modeling was not required as Alt7R included pre-storm drawdown operations.

## During 2002, there were 3 pre-storm operations implemented as follows:

- 19 September (1200) –20 Sep 2002 (1600)

Conditions: Tropical Storm Isidore was within the 72 hr error forecast cone.

- 14 October (1100) – 15 October (1100)

Conditions: Tropical Storm Watch issued. Column 1 operations of IOP were implemented on Friday 11 Oct. Column 1 Operations were in affect until 14 October when a Tropical Storm Watch was issued for the FL Keys and the Miami-Dade area at 1100, pre-storm operation were in place until 1100 on 15 October when Tropical Storm Watch was discontinued and Column 1 Operations were resumed.

- 12 - 14 December 2002

Conditions: Forecasted heavy rainfall, El Nino type frontal system. Over the previous 30 days approximately 5.62” of rainfall fell in eastern Miami-Dade Co., representing 171% of normal precipitation. Over the preceding 7 days, approximately 2.95” of rainfall fell in the area. On December 8$^{th}$ and 9$^{th}$ rainfall quantities were approximately 2.8” basin-wide, w/ most gages along the SDCS reporting 1-day values of 2-3”, and over 4” at S-332 and S-174. Operations were adjusted to utilize S-332D to avoid sending water to the lower C-111 area and data indicates that S-176 was closed on 13 December.

## During 2003, there were 3 pre-storm operations and 1 post storm recovery operation implemented as follows:

- 30 April – 1 May

Conditions: Forecasted heavy rainfall because of a low pressure impulse. Forecast called for 2" local max for 30 April and 3-4 inches for 1 May. Antecedent conditions were relatively wet for this time of year. Flood Watch was in effect.

- 29 May – 31 May (post storm recovery operation)

Conditions: Flood watch was in effect. South Dade received 5.6 inches over the previous week and projection for 29 May was for an additional 4" local maximum. A pre-storm operation was not implemented on 28 May, only a reduction in the moving of water from WCA-3A to SDCS per IOP. On 29 May, storm recovery operations were implemented as a result of rainfall.

- 23 June (1300) – 25 June (1100)

Conditions: Wet antecedent conditions and 48 hours forecast. Forecast was for 1-2" average, w/ local max. up to 3 in. for lower East Coast/Dade County Tuesday – 0.5 – 1" average with local maximum up to 2 inches. Previous 72-hr period produced 3-5 inches in South Florida.

- 29-30 September

Conditions: Storm/storm recovery was implemented. The combination of a stalled front, weak low east of Melbourne, and moisture from the tropical disturbance located near the Yucatan brought more rain than expected in Dade County. The original weather forecast called for the possible heavy rainfall by the previous weekend (27-28 September) in South Florida from the tropical disturbance in Yucatan. However, due to the tropical disturbance moving westerly, and the combination of the stalled front and low east of Melbourne, rainfall intensity picked up later than expected.

## During 2004, there were 4 pre-storm operations each associated with a major hurricane forecasted to strike Florida, operations were implemented as follows:

- 11 August

Conditions: Hurricane Charley. Hurricane watch issued for South Dade.

- 1-3 September

Conditions: Hurricane Frances. Hurricane watch issued.

- 10-11 September

Conditions: Hurricane Ivan. Hurricane watch issued.

- 23-24 September

Conditions: Hurricane Jeanne. Hurricane watch issued.

## During 2005, there were 5 pre-storm operations implemented as follows:

- 7-11 July

Conditions: Hurricane Dennis. Tropical Storm watch issued for South Dade.

- 23-29 August

Conditions: TD 12 prompted the initiation of pre-storm operations. The storm system was not a named system but the projected track, slow movement and weather signature combined to create a concern for flooding in sensitive and low-lying area. Rainfall totals of 6-10" were expected over parts of South Florida. (The system continued strengthening to tropical storm and hurricane status, subsequently named Hurricane Katrina.)

- 18-21 September

Conditions: Wet antecedent conditions due to Hurricane Katrina. TD 18 prompted initiation of pre-storm operations. Forecast was for 3-5" average, w/ local max. up to 7" for lower East Coast/Dade County. (The system continued strengthening to tropical storm and hurricane status, subsequently named Hurricane Rita.)

- 3-5 October

Conditions: Wet antecedent conditions due to Hurricane Katrina and Rita. Low pressure system developed in the Bahamas prompted the initiation of pre-storm operations. (The system continued strengthening to tropical storm, subsequently named Tropical Storm Tammy.)

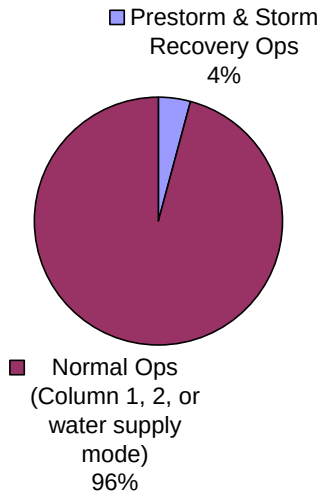
- 18-23 October

Conditions: Hurricane Wilma. Very wet antecedent conditions due to previous events. Hurricane watch issued.

**Summary Table:**

| YEAR | Pre-Storm Operations | | Post-Storm Recovery Operations |
|---|---|---|---|
| | Named | Not Named | |
| **2002** | 2 | 1 | --- |
| **2003** | --- | 3 | 1 |
| **2004** | 4 | --- | --- |
| **2005** | 2 | 3 | --- |
| **TOTAL** | **8** | **7** | **1** |

**South Dade Conveyance Operations per IOP (2002-2005)**



# WCA-3A Accounting for Column 1 to Column 2 Transition

## Introduction

For management of water levels in Water Conservation Area 3A (WCA-3A), the regulatory outlets are: S-12A, S-12B, S-12C, S-12D, S-343A, S-343B, S-344, S-333, S-151 and minimally, S-142.

The Interim Operational Plan (IOP) was implemented in June 2002 and requires that the S-12A, S-343A, S-343B and S-344 structures be closed on 1 November each year, regardless of water levels within WCA-3A. Closure of S-12B follows on 1 January and S-12C on 1 February. There is no requirement to close S-12D. All structures may be reopened on 15 July. Consequently, IOP has 3 modes of operation: Column 1, Column 2 and water supply.

1. Column 1 is the condition when regulatory releases from WCA-3A can be met by normal operation of the WCA-3A regulatory outlets.
2. Column 2 is the condition when regulatory releases from WCA-3A are made via S-333 to L-29 and L-31N, the South Dade Conveyance System (SDCS). This mode generally requires the use of pumping stations S-331, S-332B, S-332C and S-332D.
3. Water supply is the condition when structures in the SDCS reach a trigger level that indicates that water supply is required.

An interagency meeting was held on October 22, 2002 to discuss issues related to implementation of the IOP. The meeting was facilitated by Analee Mayes, a Florida-based facilitator under contract to the U.S. Institute for Environmental Conflict Resolution. The following information was documented from that meeting.

1. The determination of the extent to which IOP operations cause water to be retained in WCA-3A beyond that expected during the pre-ISOP schedule for WCA-3A is computed on the basis of flow volumes through the S-12 structures.

2. Column 2 operations will be used to offset or mitigate for adverse effects on WCA-3A of actions taken to protect subpopulation A of the Cape Sable Seaside Sparrow (CSSS). Column 2 operations will generally occur when any of the S-12 structures are closed in order to protect the CSSS. Column 2 operations may continue past reopening of the S-12s if necessary to mitigate for adverse effects on WCA-3A resulting from IOP change in the closure of the S-12s.

3. At the beginning of the wet season, (wet seasons in general span the period from late May to late October), Column 2 operations may continue long enough past reopening of the S-12s to release the volume of water that would have been

released, according to the regulatory schedule, had the S-12s been allowed to be open. It is understood that other means available will be used to lower water levels in WCA-3A and that the reduction in WCA-3A water levels using S-333/S-334 will be accomplished as quickly as possible, allowing a change to Column 1 as quickly as possible, based on the S-334 tailwater and G-3273 criteria. Likewise, at the beginning of the dry season, (dry season span the period from November to late May), Column 1 operations may continue until the capacity of the S-12s that remain open is insufficient to handle the regulatory releases from WCA-3A.

4. While operating in Column 2 mode, S-333 flows will be diverted to NESRS as much as possible based on the G-3273 constraint.

5. In keeping track of the extent to which IOP operations might cause water levels in WCA-3A to be higher than normal, the "bank account" will zero out on November 1.

6. The transition into Zone E1 in the regulation schedule for WCA-3A will be gradual, as opposed to the abrupt curve shown on the schedule in the IOP EIS.

## IOP WCA-3A Operational Summary

This following summaries of the 2002, 2003 and 2004 IOP periods are based on a simplified account of flows via the S-12A, B, C and D, S-333 and S-334 structures. The U. S. Fish and Wildlife Service (FWS), National Park Service (NPS) and South Florida Water Management District (SFWMD) reviewed the spreadsheet utilized to develop the following summary during an interagency phone conference 7 August 2003. The group agreed that a simplified method was adequate.

In addition to the accounting, a weekly operational phone conference is held each Tuesday afternoon, or whenever requested by FWS or NPS to review operations or.

### 1 Nov 2002 – 15 Jul 2003 IOP WCA-3A Operational Summary

WCA-3A reached a high stage of 10.98 ft-NGVD in mid-September 2002 declining to 10.37 ft-NGVD by November 1st when S-12A was closed. Gradually S-12B and S-12C were closed with only S-12D remaining open through the dry season. During the period WCA-3A was in Zone E1, approximately 13,800 ac-ft were released from WCA-3A via S-333. At the start of this wet season, WCA-3A transitioned rapidly from 9.44 on 26 May (Zone E1), 9.64 on 27 May (Zone C), 9.86 on 2 June (Zone B) to 10.09 on 10 June (Zone A). WCA-3A remained in Zone A through July 15th. For the period from the week of 30 May through 22 July, had the S-12s been fully opened, it is estimated that the

S-12s could have passed 1750 cfs as a weekly average. Therefore, the total amount of flow that was not passed due to the closure of the S-12A-C was 10,600 ac-ft.

Using the bank account analogy, this year there was a surplus of 3,200 ac-ft because releases during Zone E1 (13,800 ac-ft) exceeded the deficit (10,600 ac-ft) during the regulatory release period when structures S-12A-C were closed.

**IOP 2002**

| Structure | Closed | Open | Closed |
|---|---|---|---|
| S12A | 31 Oct 2002 | 22 July 2003 | 31 Oct 2003 |
| S12B | 12 Nov 2002 | 16 July 2003 | 29 Dec 2003 |
| S12C | 13 Nov 2002 | 27 Jun 2003 | 05 Jan 2004 |
| S12D | open | open | 26 May 2004 |
| S343A&B | 31 Oct 2002 | 25 July 2003 | 31 Oct 2003 |
| S344 | 31 Oct 2002 | 25 July 2003 | 31 Oct 2003 |

**1 Nov 2003 – 15 Jul 2004 IOP WCA-3A Operational Summary**

WCA-3A reached a high stage of 11.54 ft-NGVD on 29 September 2003 declining to 11.05 ft-NGVD by 31 October when S-12A was closed. S-12B closed in December, S-12C in January and S-12D by May 2004. WCA-3A was above the regulation schedule and called for maximum releases from 31 October until the 26 November and remained in Zone C until 8 December 2004.

Column 2 regulatory releases to the SDCS were made during the period from 1 Nov 2003 through 31 December and transitioned to water supply by 1$^{st}$ week in January 2004.

WCA-3A was in Zone E1 from 1 March to 21 March 2004. During the period in Zone E1, S-334 was opened minimally open for water supply to the SDCS. The discharges from S-333 were utilized to maintain the hydration of NESRS. WCA-3A remained in Zone E through the dry season until the week of 3 July 2004 when stages reentered Zone E1. No additional Zone E1 releases were made due to the dryer than normal start of the wet season.

The S-12s were transitioned from open to closed at the end of the regulatory period over a span of 5 weeks during the reminder of December until 5 January 2004. Discharges from the S-11 structures (regulatory outlets for WCA-2A) were reduced to minimize impacts on WCA-3A from about mid-September onward. Therefore, the closing of the S-12s were transitioned even past the period that the WCA-3A declined below Zone C to compensate for the S-11 discharges. This was discussed with FWS and NPS with concurrence. This strategy reduced the peak stages in WCA-3A.

Also during the period that WCA-3A was in Zone E, the Lake Okeechobee Water Supply/Environmental (WSE) regulation schedule was in a temporary deviation to attempt to lower stages in the Lake. Some water was routed from Lake Okeechobee via WCA-3A to NESRS via S-333 at the concurrence of NPS with no residual changes to the level in WCA-3A.

Using the bank account analogy, Column 2 operations were not utilized during the period that WCA-3A was in Zone E1 between 1 November 2003 and 15 July 2004; therefore, no deficit or accrual was recorded.

**IOP 2003**

| Structure | Closed | Open | Closed |
|---|---|---|---|
| S12A | 31 Oct 2003 | 26 Aug 2004 | 31 Oct 2004 |
| S12B | 29 Dec 2003 | 27 Aug 2004 | 06 Dec 2004 |
| S12C | 05 Jan 2004 | 10 Aug 2004 | 13 Dec 2004 |
| S12D | 26 May 2004 | 10 Aug 2004 | 07 Jan 2005 |
| S343A&B | 31 Oct 2003 | 26 Aug 2004 | 31 Oct 2004 |
| S344 | 31 Oct 2003 | 26 Aug 2004 | 31 Oct 2004 |

**1 Nov 2004 – 15 Jul 2005 IOP WCA-3A Operational Summary**

WCA-3A reached a high stage of 11.74 ft-NGVD on 15 October 2004 declining to 11.40 ft-NGVD by 31 October when S-12A was closed. S-12B and C were closed in December and S-12D by January 2005. WCA-3A was above the regulation schedule and called for maximum releases from 31 October until the week of 21 November and remained in Zone C until 3 December 2004. The WCA-3A stage continued to decline due to a rainfall deficit and was 9.13 ft-NGVD by 2 May 2005. Stages increased to 9.59 on 5 May 2005 then declined to 9.22 by 29 May. From 30 May stages increased reaching a peak on 11.71 on 16 July. There was above average rainfall in June - early opening of the S-12 was requested and granted for opening on 22 Jun 2005.

**IOP 2004**

| Structure | Closed | Open | Closed |
|---|---|---|---|
| S12A | 31 Oct 2004 | 22 Jun 2005 | 15 Nov 2005 |
| S12B | 06 Dec 2004 | 22 Jun 2005 | |
| S12C | 13 Dec 2004 | 22 Jun 2005 | |
| S12D | 07 Jan 2005 | 31 Mar 2005 | |
| S343A&B | 31 Oct 2004 | | 01 Nov 2005 |
| S344 | 31 Oct 2004 | | 01 Nov 2005 |

# S-356 Pumping Test (*7/16/06)*

Test Objectives: The primary objective of the test is to acquire hydrologic data on how the existing system responds to S-356 pumping including, but not limited to, the following:

- The stage response along the L-29 canal and corresponding flow through the existing culverts into NESRS for the tested pumping rates.
- The drawdown in the L-31N canal along the canal reach from S-335 to G-211, which is the source of the water pumped by S-356.
- The distribution of water flow in NESRS and the ability of the pumped water to maintain (raise water levels compared to the without-pumping condition) along the eastern boundary of NESRS.
- How pumping affects water levels east of the L-31N canal (rate and magnitude).
- Obtain and analyze water quality samples to provide water quality information for these conditions.

This test will provide information on the ability of the S-356 pump station to capture and return seepage from NESRS allowed by the Interim Operation Plan for Protection of the Cape Sable Seaside Sparrow (IOP for Protection of the CSSS). If this objective can not be achieved, a secondary objective would be to acquire sufficient hydrologic data to formulate a series of tests to derive operations for S-356 consistent with the original IOP intent to implement until the completion of CSOP. This would be achieved through the following:

a. Observe the drawdown and flow rate in L-31N associated with S-356 operations.

b. Compare results with the previous L-31N drawdown test, which utilized S-331 as the control feature, located south of G-211.

c. Observe the response in the L-29 canal levels to the S-356 pump test.

d. Through detailed water budgets, characterize inflows along L-31N from the natural areas to the west and developed lands to the east.

e. Provide water quality characterization to identify phosphorus load content under S-356 operations (specifically contribution from coastal structures).

f. Gather hydrologic and water quality data.

Test Description: The test will be conducted using the S-356 pump station and S-338 as the primary control features, and S-335 as a secondary control feature. The test also involves water control features S-333, S-334, S-336, S-380, G-211, S-356, S-355A, S-355B located along L-29, L-30, and L-31N. The preference is to perform the test when no S-335 or S-338 discharges are required, the water level at G-3273 is below 6.8, and water conditions are relatively wet (water above ground surface along the L-31N levee).

This ideal condition may not be available as releases may be occurring through either S-335 or S-338 or both. If S-335 is open, a minimum sustainable gate setting providing a relatively stable flow will be established for the test duration. Once the S-335 gate opening and corresponding flow are set, the flow rate at S-338 and the stage in the L-31N canal will be assessed to determine if the flow reduction at S-338 is consistent with the S-356 pumping rate and test objectives. This process would be repeated at each increase in the S-356 pumping rate. It is expected that the S-338 flow reduction would be similar in magnitude to the change in pumping rate at S-356.

Stream-gauging data at selected areas adjacent to the junction of L-29, L-30, and L-31N will be recorded for analysis. Refer to Figure 1 for data gathering locations. Continuous coordination will occur between SFWMD, ENP, FWS, FDEP, and the Corps for the entire testing period. A conference call number will be set up for use on a daily basis or as needed. This test can be terminated at any time as determined by the team.

Background: In accordance with the IOP for protection of the CSSS, a technical team is responsible for evaluating S-356 pumping limits and operations.

An L-31N drawdown test was performed in May 2004. The primary test objectives were to determine the total seepage into the L-31N canal and what portions of this seepage occur from WCA-3B into the L-31N canal between S-335 and Tamiami Trail, and from ENP into the L-31N canal between Tamiami Trail and S-331. For the previous test, the S-331 pump station was the control feature. Based upon the May 2004 L-31N drawdown test, it is acknowledged that the area near S-356 has the highest transmissivity and, correspondingly, seepage.

To prevent an unrepresentatively large contribution of water from the east side of the L-31N canal, an appropriate S-356 pumping rate and releases from S-335 will be used to prevent the L-31N canal stage from following below the groundwater level at Krome Avenue. The S-335 structure will be used only as necessary (minimum release) to maintain the L-31N stage as measured at the S-336 HW above the stage of G-3558. The testing plan is to incrementally adjust the S-356 pumping rates without inflow from S-335 until either (1) the last pumping rate results in an L-31N stage just above the stage at G-3558 or (2) insufficient water is available from the L-31N reach from S-335 to G-211 and S-335 is used to provide the deficit, resulting in a stabilized L-31N stage just above the stage at G-3558. More specifically, the S-335 structure may be used to provide sufficient water to allow quasi stabilization of the canal stages at the last pumping rate if insufficient water is available from the L-31N reach between S-335 and G-211.

Proposed Operations (Contractor initiated pumping on August 1, 2006 based on the required 7 days of notification):

- Close S-333, S-355A, S-355B, S-334, S-336, S-380, and G-211. The intent is to create a closed system in both L-29 and L-31N.
- Cease or reduce the discharge from S-335 and S-338 in anticipation of initiating the S-356 pumping rate.

- Begin S-356 pumping operations by starting one diesel pump ($Q_{Total}$ = 125 cfs) and, if necessary, reduce the discharge from S-338.
- Wait until steady-state conditions are achieved in L-31N. This is expected to take 1 to 2 days.
- Start a second diesel pump ($Q_{Total}$ = 250 cfs)*.
- Cease or reduce the discharge from S-335 and S-338 in anticipation of increasing the S-356 pumping rate.
- Wait until steady state conditions are achieved in L-31N.
- If steady state conditions are not achieved, bring water via S-335 as necessary to achieve steady-state conditions.

For this test, pumping rates above 250 cfs require written (e-mail or facsimile) approval by FWS staff due to concerns about the potential impact of increased stages in drier portions of NESRS located along the L-31N canal on the availability of prey for woodstork fledglings. If field observations by FWS staff indicate either tolerable water levels or a lack of foraging, higher pumping rates may be tested, contingent on both the FWS written approval and sufficient seepage. If pumping above 250 cfs is approved, the following procedure will be used. The 250 cfs pumping rate will be maintained for an amount of time sufficient for the system to adjust to this pumping rate and for FWS to assess the conditions. It should be noted that continued pumping (at any pumping rate) is contingent on the water level not exceeding 6.8 feet NGVD for 24 hours and maintaining the L-31N stage higher than the groundwater stage at G-3558.

- Start a third diesel pump ($Q_{Total}$ = 375 cfs).*
- Cease or reduce the discharge from S-335 and S-338 in anticipation of increasing the S-356 pumping rate.
- Wait until steady-state conditions are achieved in L-31N.
- If steady-state conditions are not achieved, bring water via S-335 as necessary to achieve steady-state conditions.
- Start a fourth diesel pump ($Q_{Total}$ = 500 cfs).*
- Cease or reduce the discharge from S-335 and S-338 in anticipation of increasing the S-356 pumping rate.
- Wait until steady-state conditions are achieved in L-31N.
- If steady-state conditions are not achieved, bring water via S-335 as necessary to achieve steady-state conditions.

* NOTES:

1. Do not start an additional pump if levels in L-31N recede or are expected to recede below the stage at G-3558.
2. Maintain constant pumping for at least 24 hours.
3. L-29 stage will be monitored continuously to avoid levels above 8.0 feet NGVD.

End of test pumping:

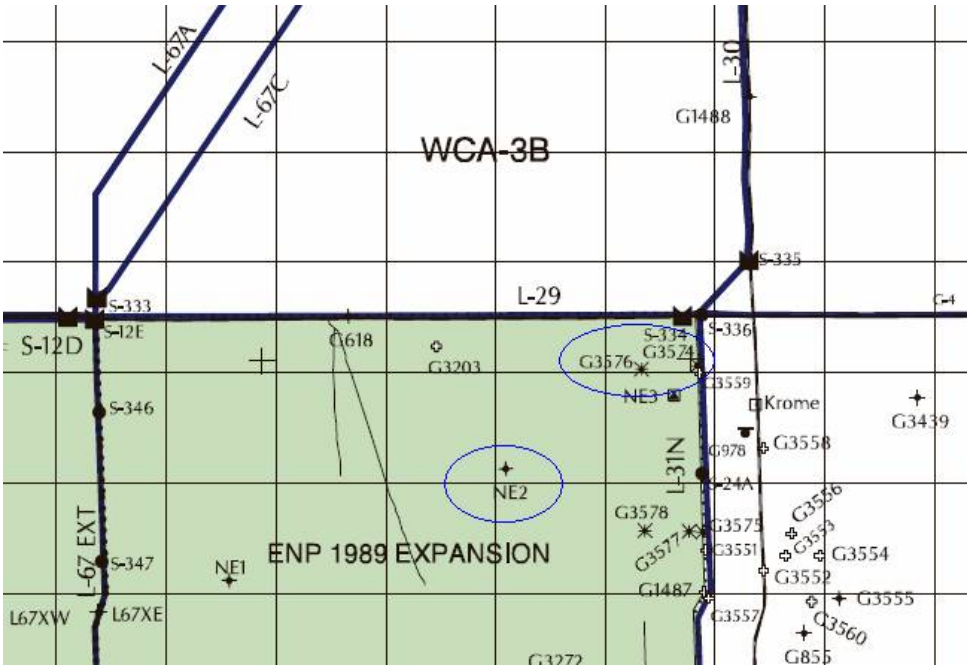
- Cease inflow and allow recovery for 24 hours.

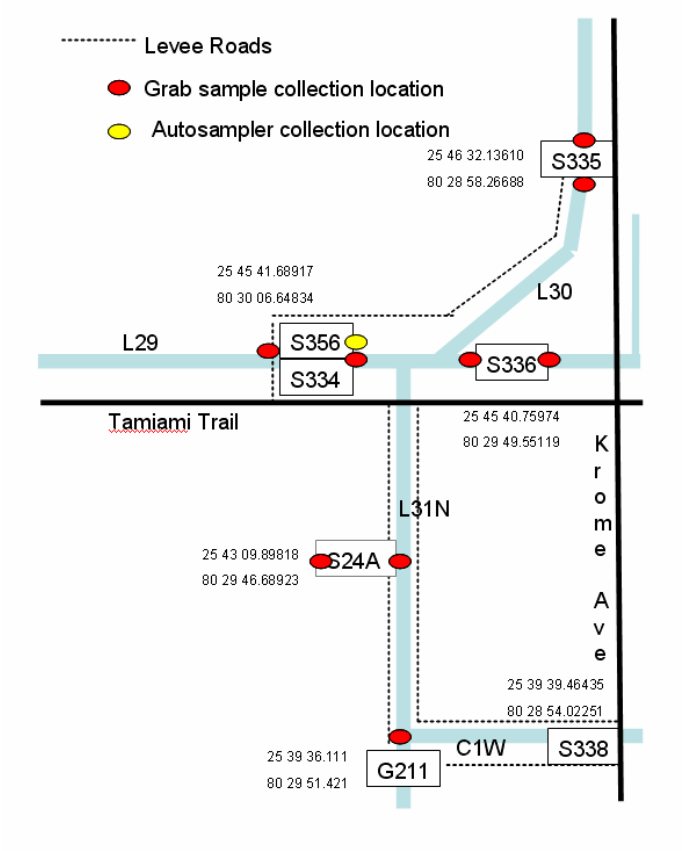
Day after the end of test pumping

- Normal operations on all structures should resume.

Constraints:

- Minimum elevation of 4.0 feet NGVD as measured at G-211 headwater.
- The S-356 pumping test should not result in an S-336 HW stage lower than the stage at G-3558.
- G-3273 must be below 6.8 feet NGVD (not to exceed 6.8 feet NGVD for a 24-hour period).
- L-29 stages, measured at the S-334 HW, exceeding 8.0 feet NGVD require assessment and potential FDOT notification. If the L-29 stage exceeds 7.8 feet NGVD, the likelihood of exceeding 8.0 feet NGVD for more than 2 days and the stage will be assessed and corresponding actions identified and implemented as necessary.






During this initial S-356 pump test in August 2006, the Miccosukee Tribe of Indians objected to the test. The Corps continues to analyze the results from this test and will coordinate these test results, as well as planning for any future tests, with the Miccosukee Tribe of Indians, FDEP, SFWMD, FWS, and ENP.

# S-356 Pumping Test Summary

**Test Objectives:** The primary objective of the test was to acquire hydrologic data on how the existing system responded to S-356 pumping including but not limited to the following:

- The stage response along the L-29 canal and corresponding flow through the existing culverts into Northeast Shark Slough (NESS) for the tested pumping rates.
- The drawdown in L-31N canal along the canal reach from S-335 to G-211 which is the source of the water pumped by S-356.
- The distribution of water flow in NESS and the ability of the pumped water to maintain (raise water levels compared to the without pumping condition) along the eastern boundary of NESS.
- How pumping affects water levels East of the L-31N canal (rate and magnitude).
- Obtain and analyze water quality samples to provide water quality information for these conditions.

This test provided information on the ability of the S-356 pump station to capture and return seepage from NESS allowed by the Interim Operation Plan for Protection of the Cape Sable Seaside Sparrow (IOP for Protection of the CSSS).

**Summary of Operations:**

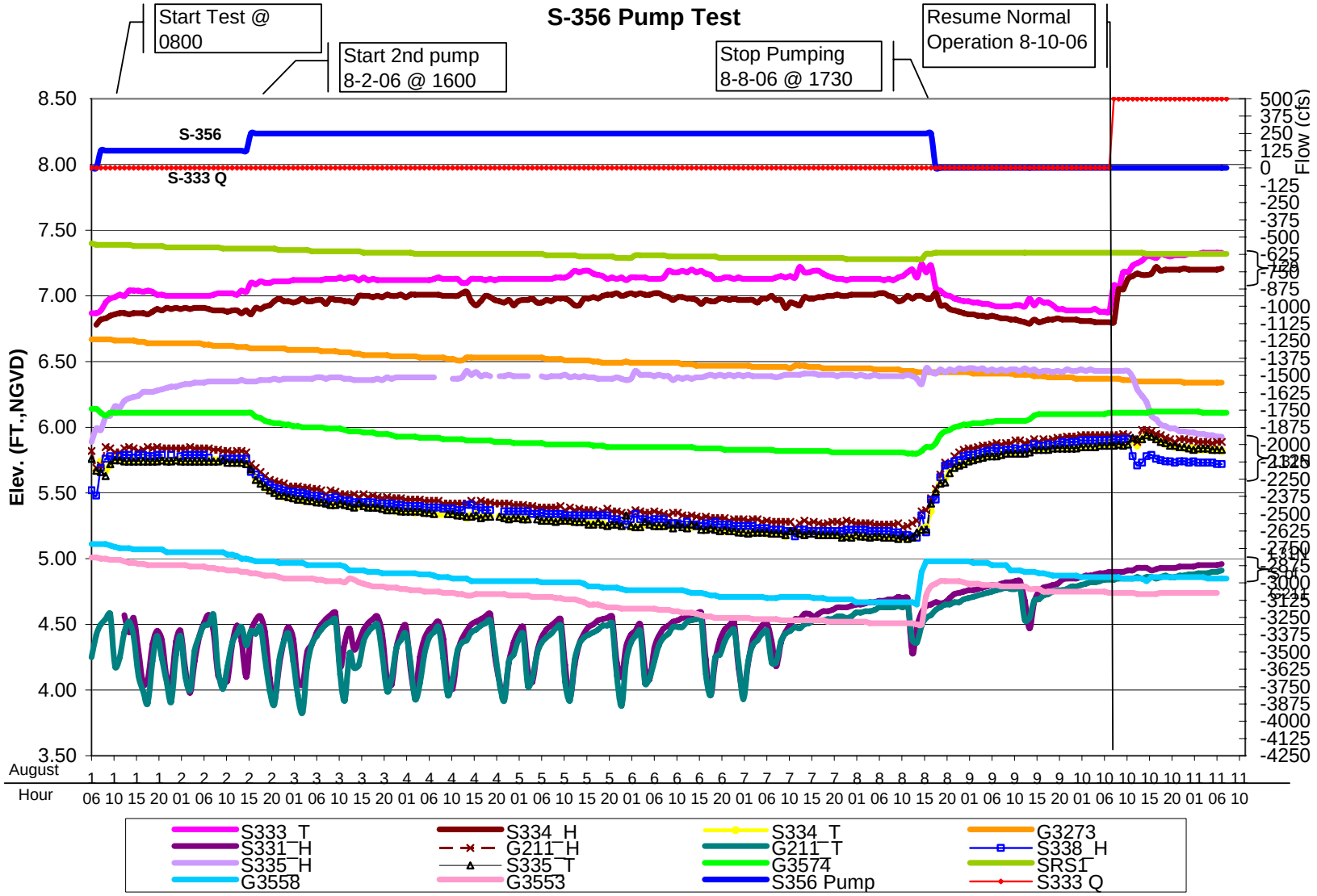
- Closed S-333, S-355A, S-355B, S-334, S-336, S-380, and G-211. The intent was to create a closed system in both, L-29 and L-31N.
- Ceased discharge from S-335 and S-338 in anticipation of initiating the S-356 pumping rate.
- Began S-356 pumping operations by starting 1 diesel pump ($Q_{Total}$ = 125 cfs) at 0800 on 8/1/06.
- Waited until steady state conditions were achieved in L-31N.
- Started a second diesel pump ($Q_{Total}$ = 250 cfs) at 1600 on 8/2/06.
- Maintained both diesel pumps ($Q_{Total}$ = 250 cfs).
- Both diesel pumps ($Q_{Total}$ = 0 cfs) cut off at 1730 on 8/8/06.
- Ceased inflow and allowed recovery for 24 hours.
- Normal operations resumed on 8/10/06. S-333 began discharging ($Q_{Total}$ = 500 cfs) at 0800 on 8/10/06.

For the entire period of the test, the following constraints were met:

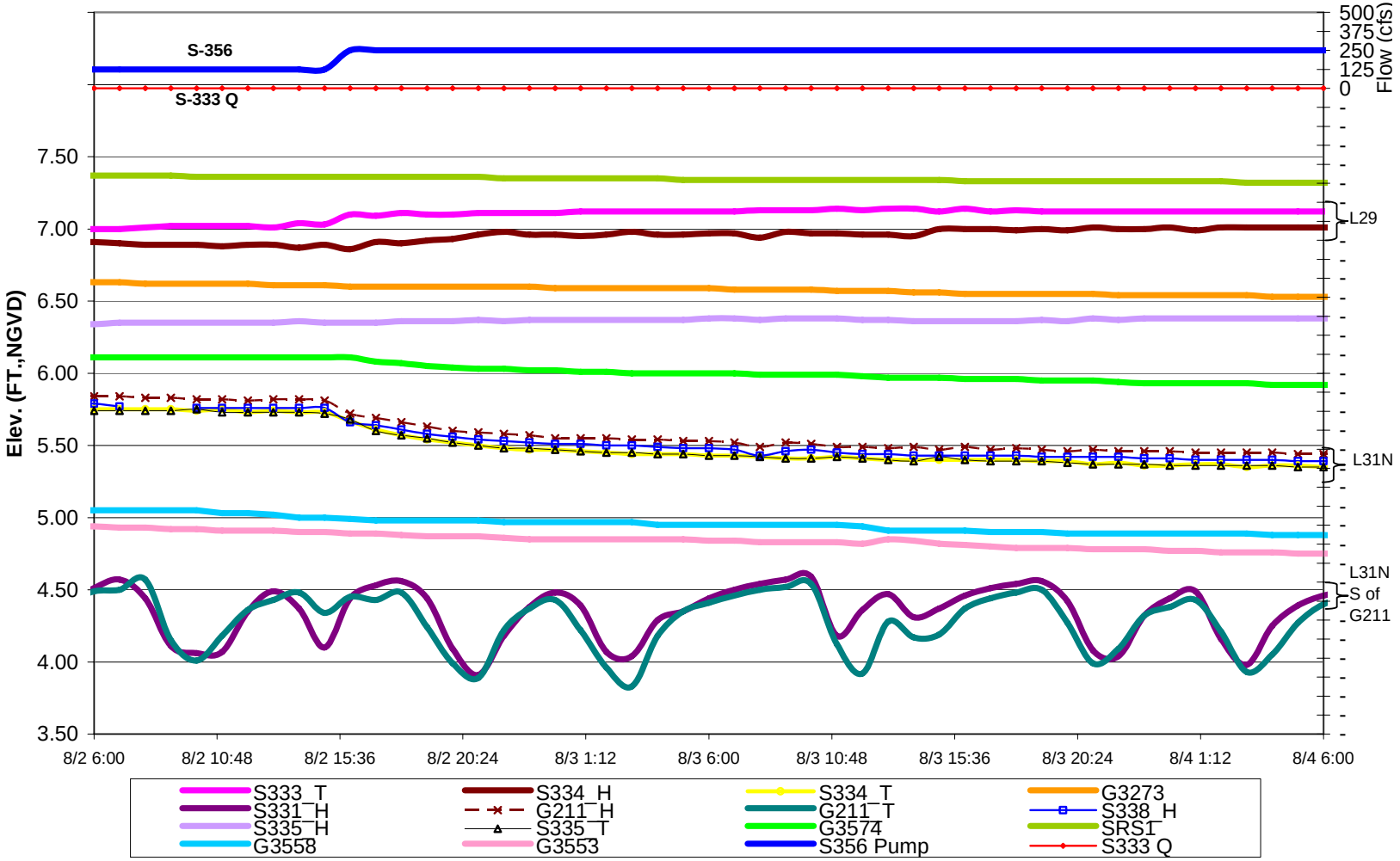
- G-3273 remained under 6.8 feet-NGVD.
- G-211 headwater remained above a minimum elevation of 4.0 feet-NGVD.
- S-336 HW remained above the stage at G-3558.
- L-29 stages, measured at the S-334 HW, did not exceed 7.5 feet-NGVD.

**Observations:** After creating a closed system, stages began to rise in L-31N. Start of first pump (125 cfs) at S-356 resulted in immediate increase in L-29, which became steady after a matter of hours. First pump had little to no impact on L-31N. After second pump was started (250 cfs), a slight rise in L-29 was observed in L-29 along with a drawdown in L-31N and groundwater wells in the vicinity. Over the 6 days of pumping 250 cfs, stages in L-29 remained steady, while L-31N stages continued to be drawn down. When pumping was turned off (still keeping closed system), L-29 returned to pre-test stages and L-31N increased rapidly back up to pre-test levels. This was also evident in the groundwater wells. When normal operation resumed on 8/10/06, L-29 quickly rose again in stage.

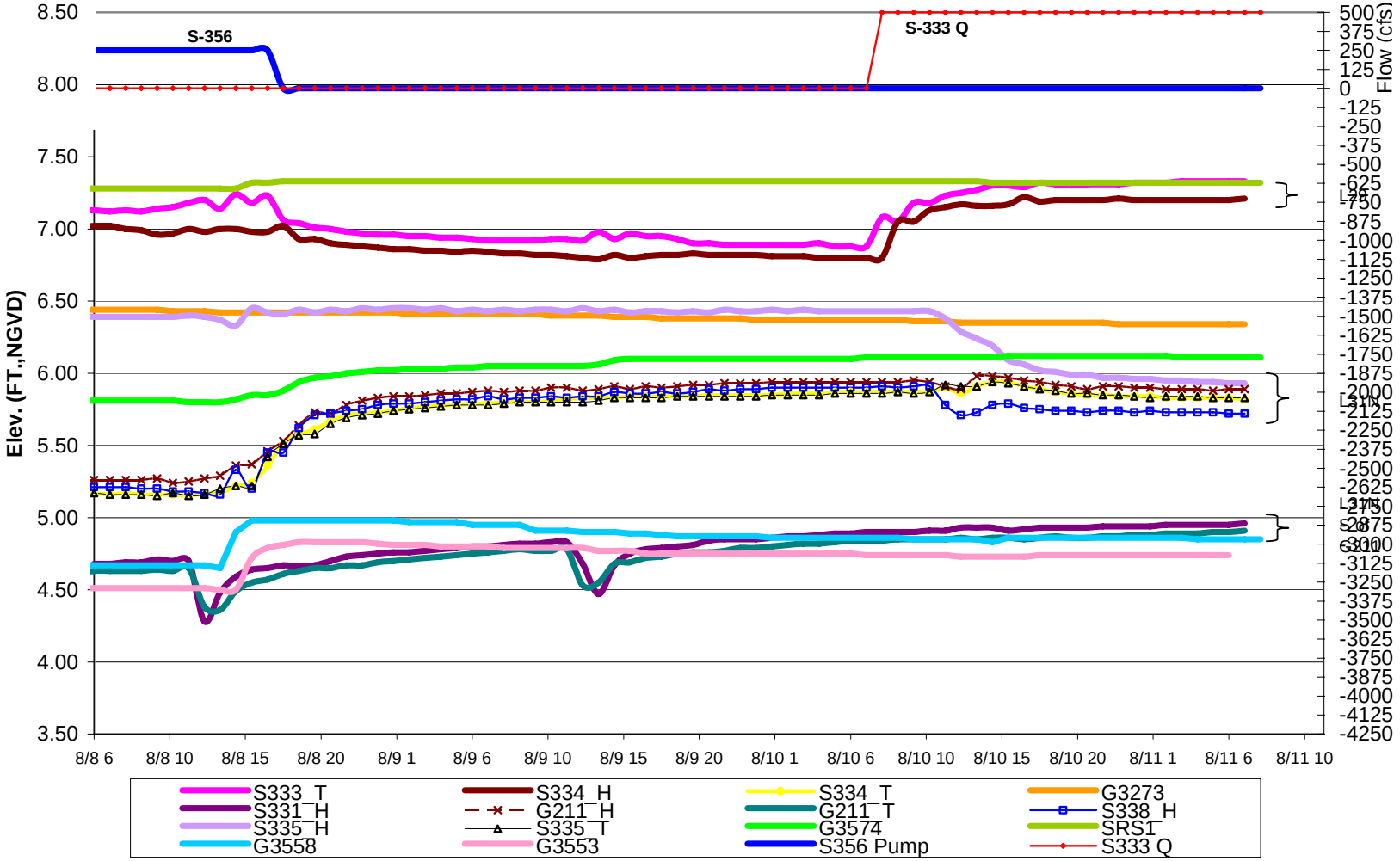
**Conclusion:** The test provided good opportunity to see how much stage response would be observed in L-29 and L-31N from pumping. Poor communication with Miccosukee Tribe led to shortened duration of test. Overall, pumping at S-356 while under a closed system allowed for drawdown of the L-31N canal. This drawdown created only a slight increase in L-29 canal stages. Neither L-29 nor L-31N levels were significantly affected by the single 125 cfs pump. Noticeable change in L-31N stages was evident after starting two pumps totaling 250 cfs. Stages in WCA-3B and NESRS were not significantly affected by pumping and continued to recede. Conclusions cannot be drawn specifically to whether seepage was successfully being captured by S-356. The drawdown of L-31N due to pumping did cause for pull on the aquifer by the canal at NESS20. It is recommended that further testing of a longer duration be conducted to gain more information.


S-356 Pump Test
Start Test @ 0800
Start 2nd pump 8-2-06 @ 1600
Stop Pumping 8-8-06 @ 1730
Resume Normal Operation 8-10-06
S-356
S-333 Q
Elev. (FT.,NGVD)
Flow (cfs)
August
Hour
S333_T
S334_H
S334_T
G3273
S331_H
G211_H
G211_T
S338_H
S335_H
S335_T
G3574
SRS1
G3558
G3553
S356 Pump
S333 Q

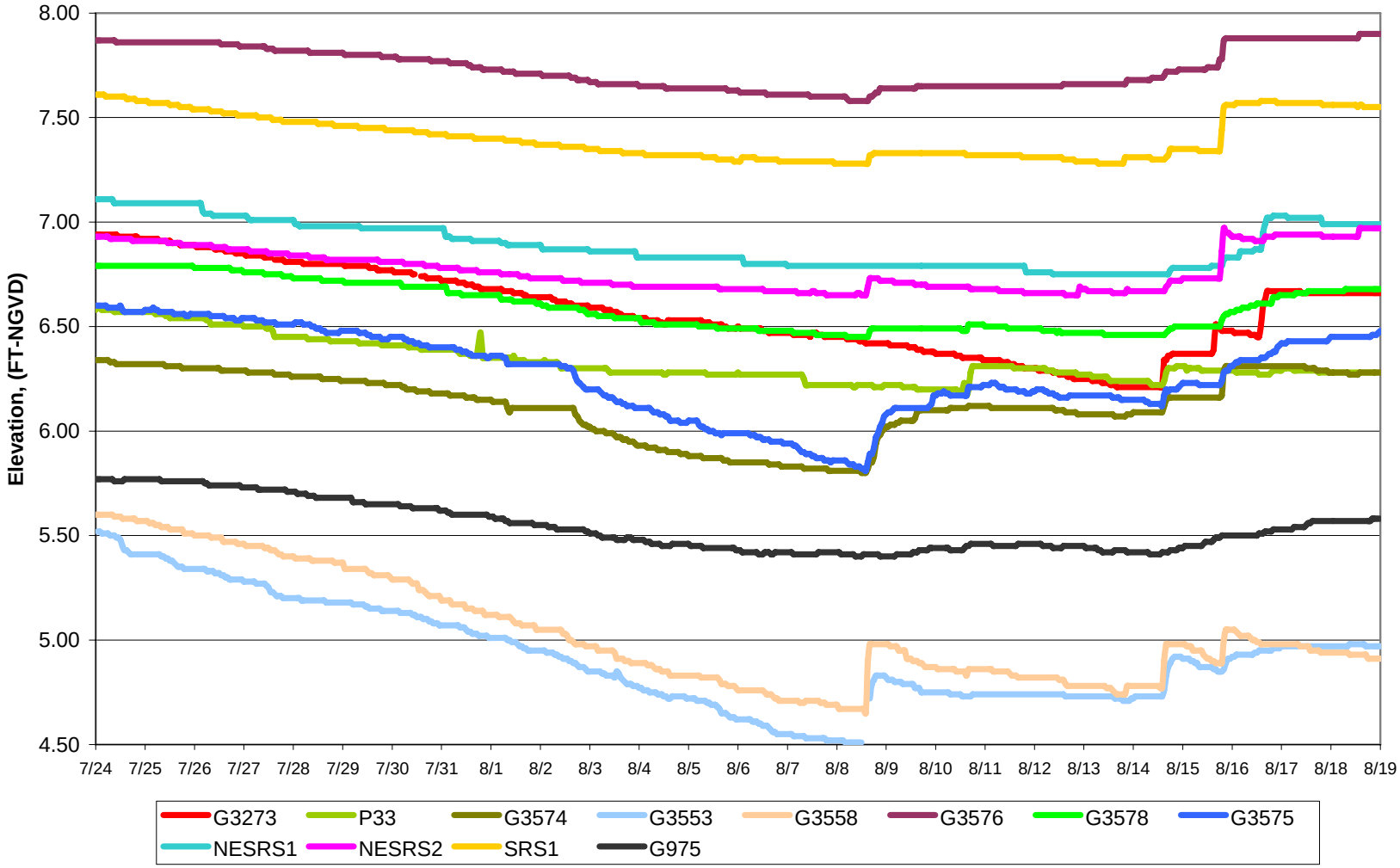
# S-356 Pump Test



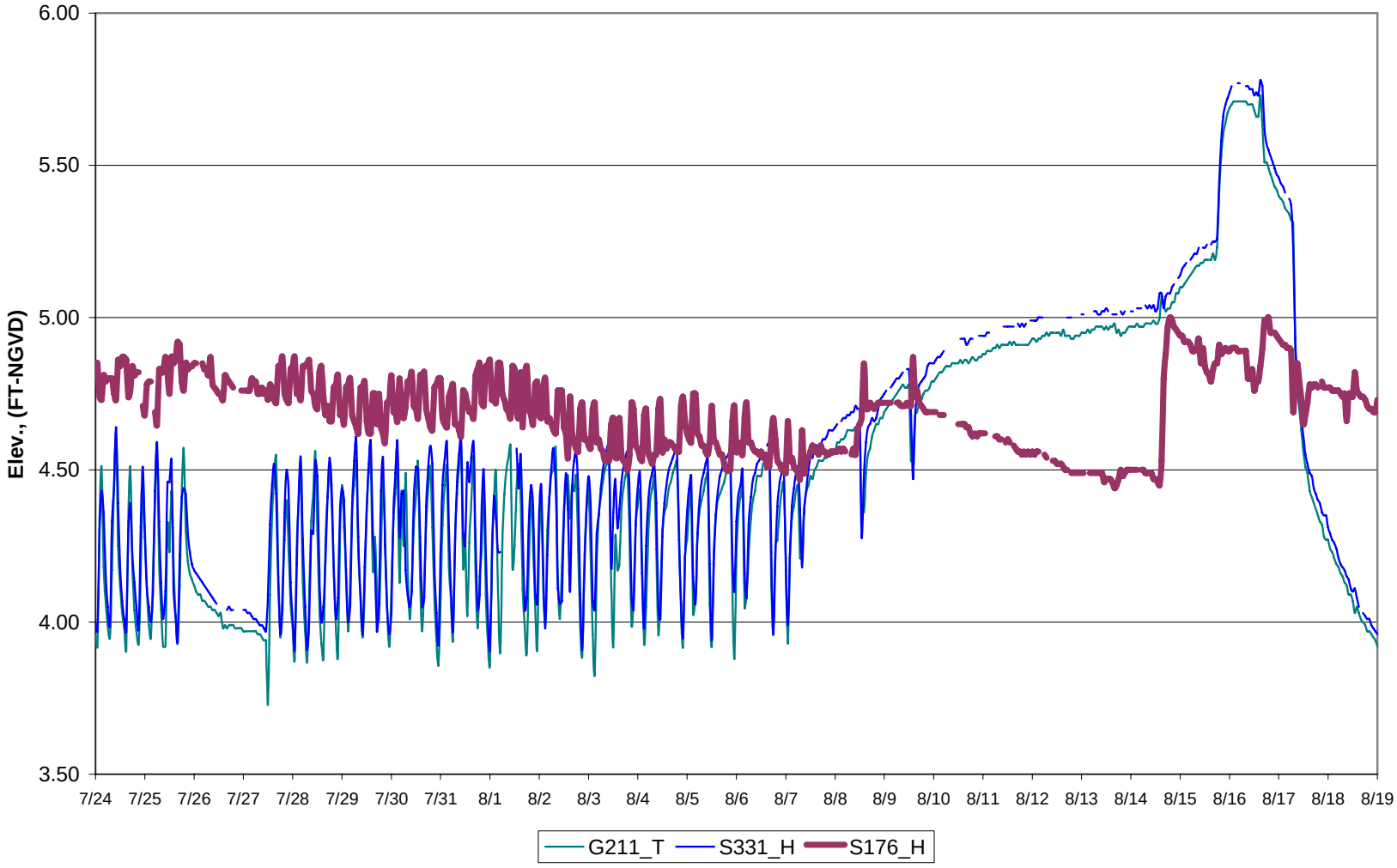
# S-356 Pump Test



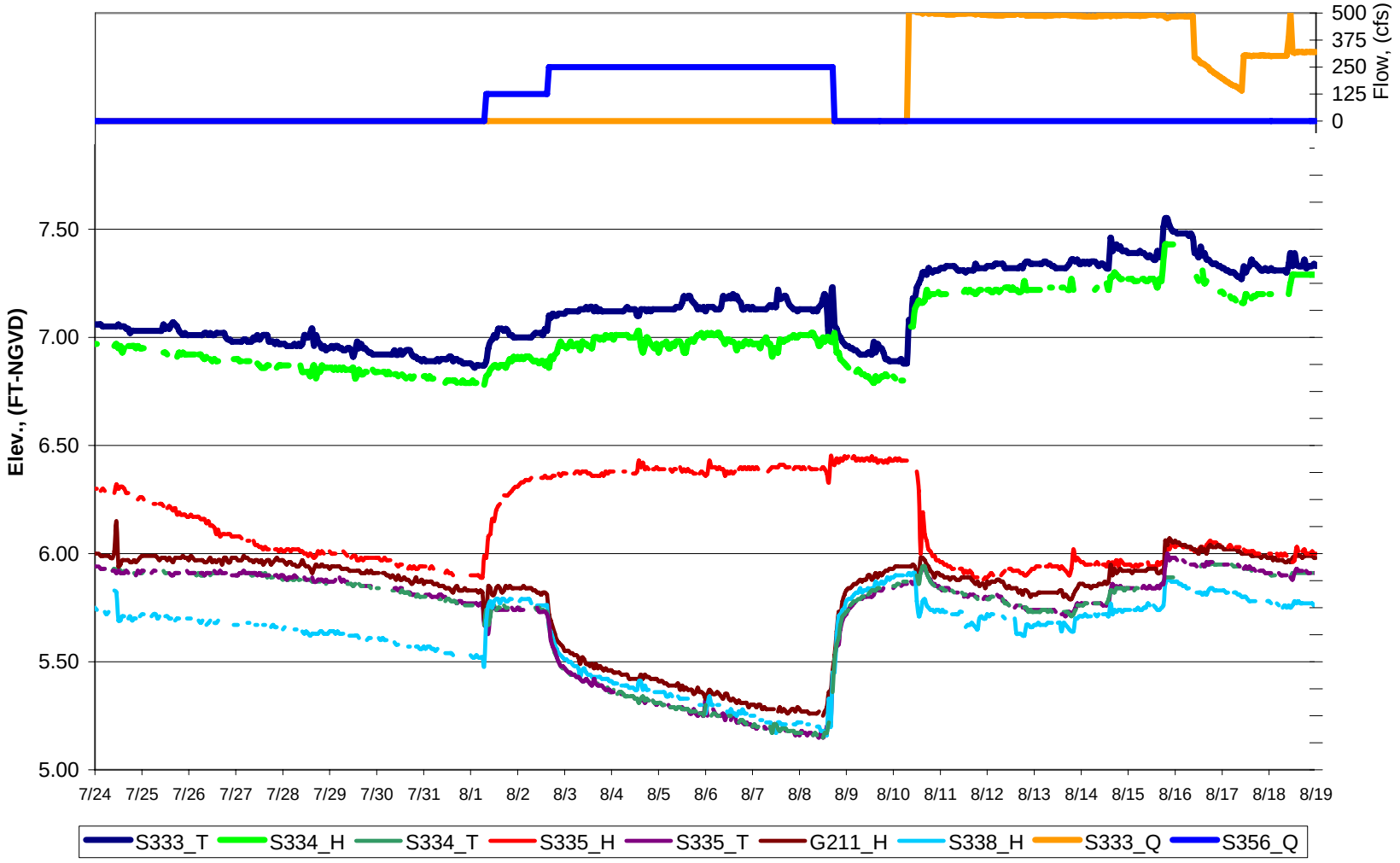
## Groundwater Wells

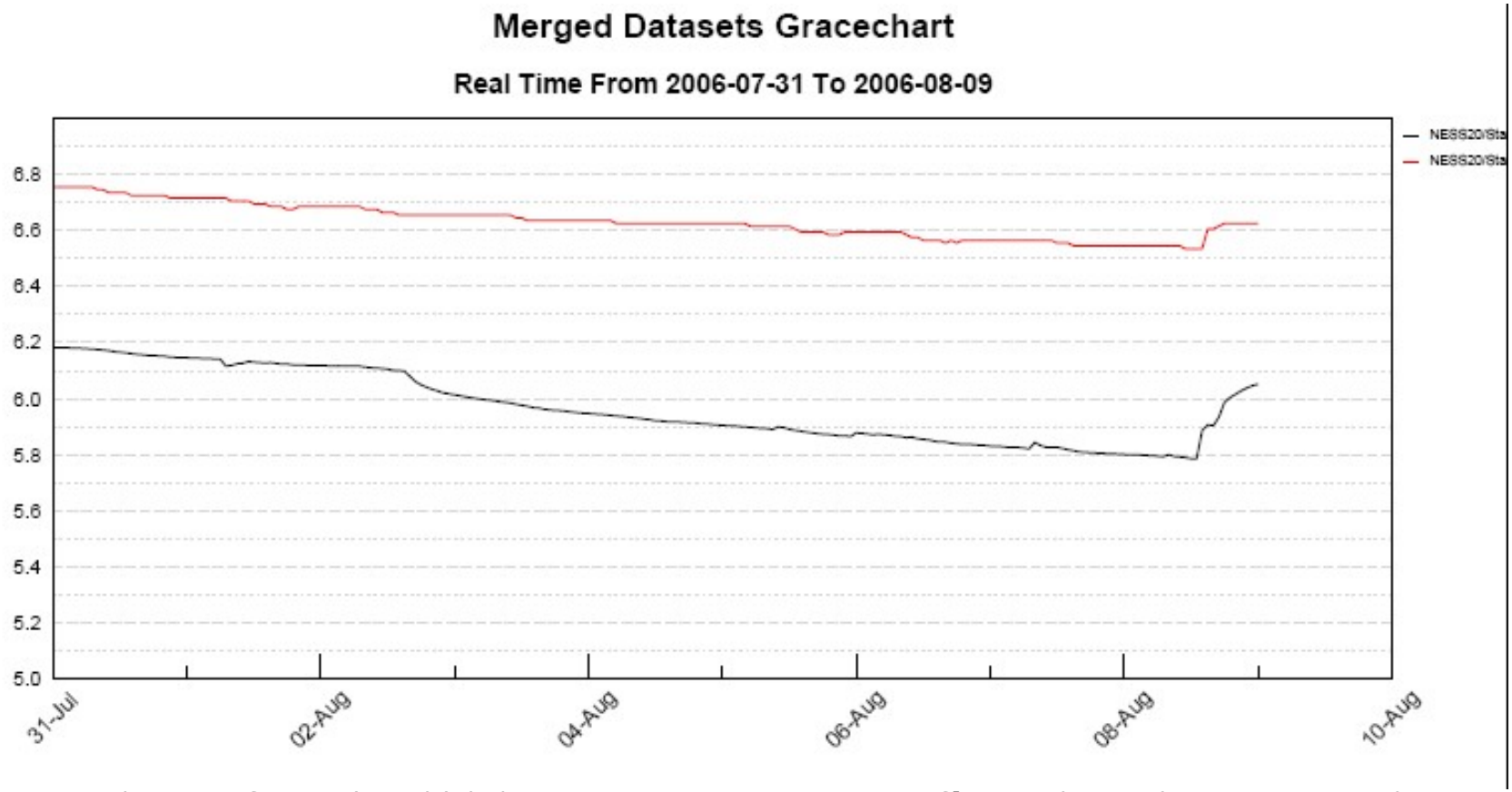


## L-31N South of G-211



## L-29 & L-31N


Flow, (cfs)
500
375
250
125
0
Elev., (FT-NGVD)
7.50
7.00
6.50
6.00
5.50
5.00
7/24 7/25 7/26 7/27 7/28 7/29 7/30 7/31 8/1 8/2 8/3 8/4 8/5 8/6 8/7 8/8 8/9 8/10 8/11 8/12 8/13 8/14 8/15 8/16 8/17 8/18 8/19
S333_T
S334_H
S334_T
S335_H
S335_T
G211_H
S338_H
S333_Q
S356_Q




We can see the 250 cfs pumping which began on 2006-08-02 at 16:00 flattened out the NESS20 SW and we can see the pull on the aquifer by the canal. This is the water level in the aquifer plotted with the water level in the marsh.

**From:** Musalem, Rodrigo
**Sent:** Tuesday, September 05, 2006 12:07 PM
**To:** Linton, Paul
**Cc:** Goodson, John
**Subject:** RE: S-356 Flow Transect Measurements.

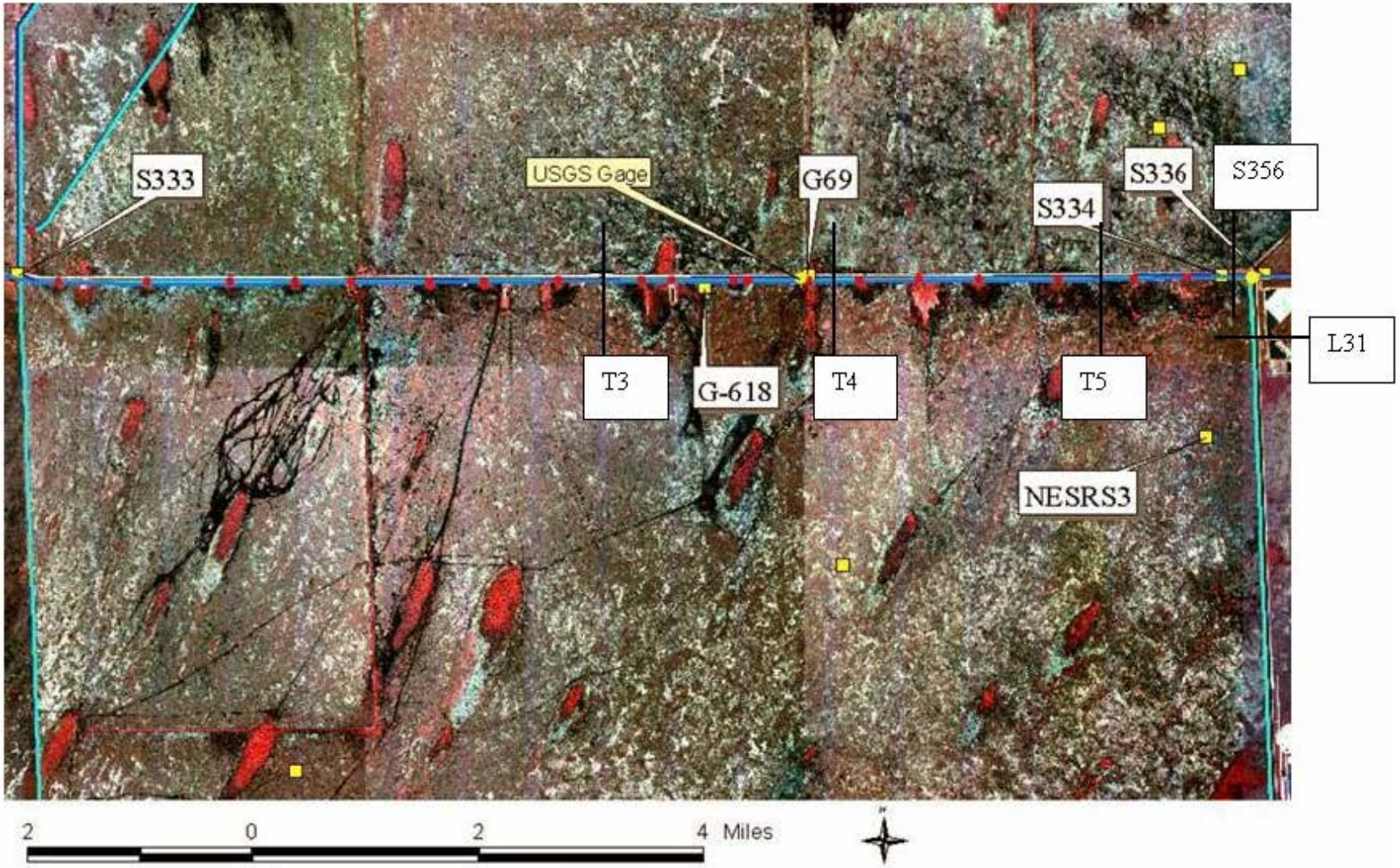
Paul,

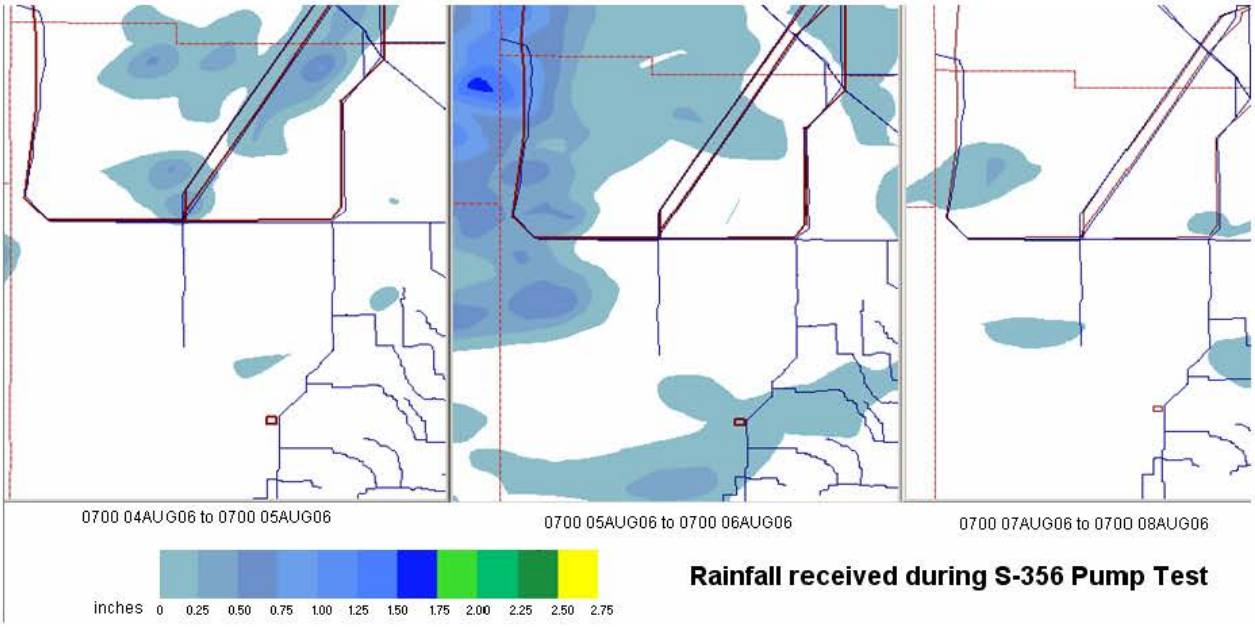
I apologize for the delay in reporting the flow measurements taken at S356 and surroundings. For multiple reasons these measurements did not come to be as good they should. As you can see from the table below, some of measurements have high uncertainties associated, especially those by the L31 canal where according to the contractor the flow was very unsteady.

As I said before I still do not get a full report from the contractor who took the measurements. It seems like some of the measurements you requested on the L-29 canal could not be taken due to adverse weather conditions.

The table below summarizes the discharge measurements. The aerial view indicates the locations where the different measurements took place.

| Date | Location of the measurement | Measured Discharge [cfs] | Flow main direction | Standard Deviation of the flow | Comments | Pump Operation |
|---|---|---|---|---|---|---|
| 8/2/2006 | L31 | < ~20 | North | - | | #4 @ 1800 |
| | S356 | 117 | West | | | |
| 8/4/2006 | L31 | ~125 | North | 35% | Flow is Pulsing | #3 @ 1800 |
| | S356 | 261 | West | 3% | | #4 @ 1800 |
| 8/8/2006 | L31 | ~83 | North | 20% | | #3 @ 1800 #4 @ 1800 |
| | S356 | 241 | West | 4% | | |
| | T3 | - | - | - | - | |
| | T4 | - | - | - | - | |
| | T5 | - | - | - | - | |
| 8/11/2006 | L31 | ~279 | South | 8% | - | All Pumps off |
| | S356 | < ~20 | - | - | - | |
| | T3 | 376 | East | 5% | - | |
| | T4 | - | - | - | - | |
| | T5 | - | - | - | - | |


S333
USGS Gage
G69
S334
S336
S356
L31
T3
G-618
T4
T5
NESRS3
2
0
2
4 Miles


0700 04AUG06 to 0700 05AUG06
0700 05AUG06 to 0700 06AUG06
0700 07AUG06 to 0700 08AUG06
inches
0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
Rainfall received during S-356 Pump Test