

# WATER QUALITY MONITORING PROJECT FOR DEMONSTRATION OF CANAL REMEDIATION METHODS FLORIDA KEYS

Report of activities: September 7<sup>th</sup>, 2016

Presented to:

Florida Keys National Marine Sanctuary Steering Committee

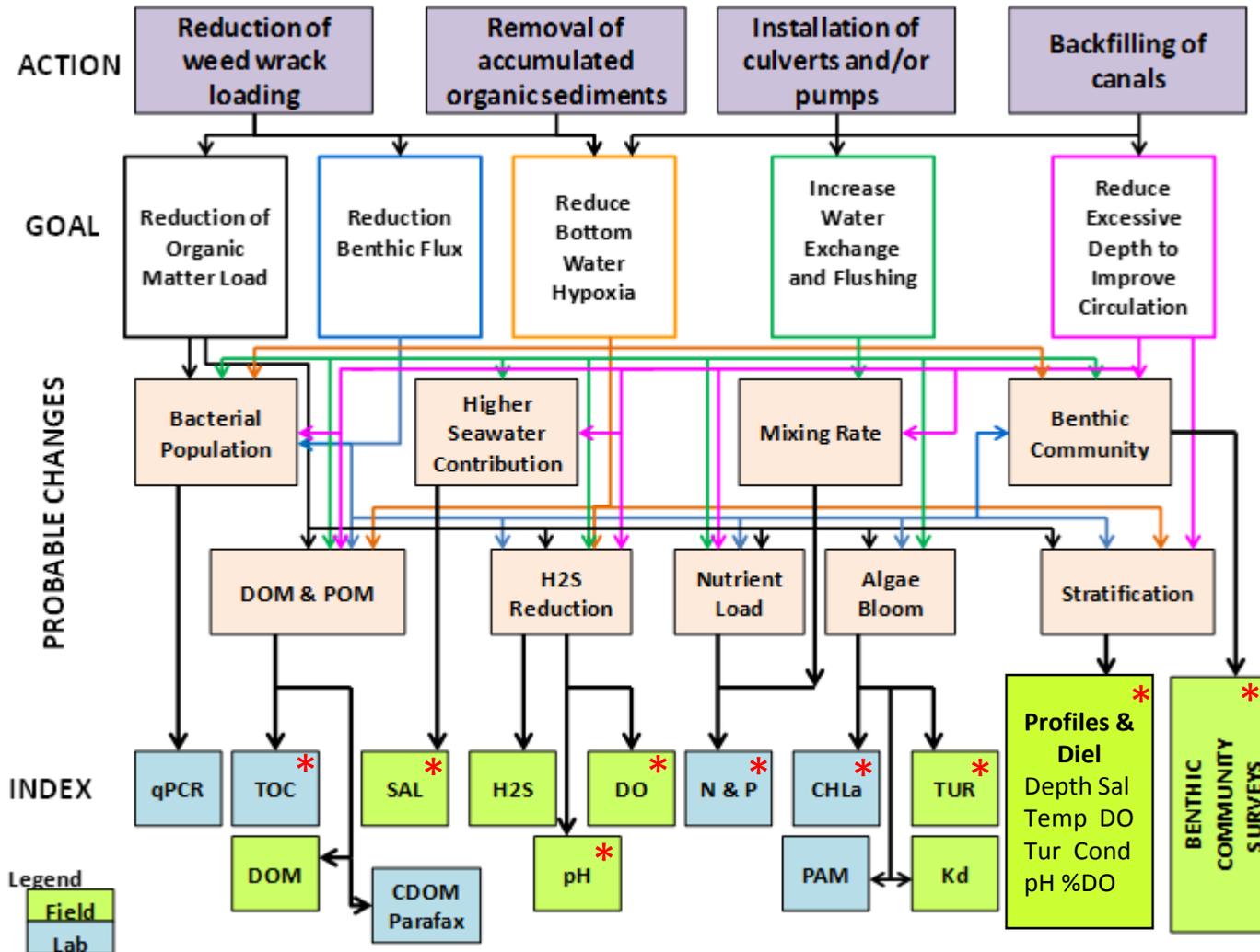


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# **WATER QUALITY MONITORING PROJECT FOR DEMONSTRATION OF CANAL REMEDIATION METHODS FLORIDA KEYS**

## **Objective**

To provide data needed to make unbiased, statistically rigorous statements about the status and temporal trends of water quality parameters in the remediated canals



\* Currently measured

## Conceptual Model

## **STRATEGY for MONITORING**

### **Monitor** Water Quality (Physical-Chemical Properties)

- Vertical profiles at selected canal sites
- Continuous 24 (72) hour recording (Diels) of physical-chemical data

### **Tracing** Canal recovery trajectory

### **Comparing** Remediated canal water to Control canal waters

### **Assessing** Status with respect to established Target levels

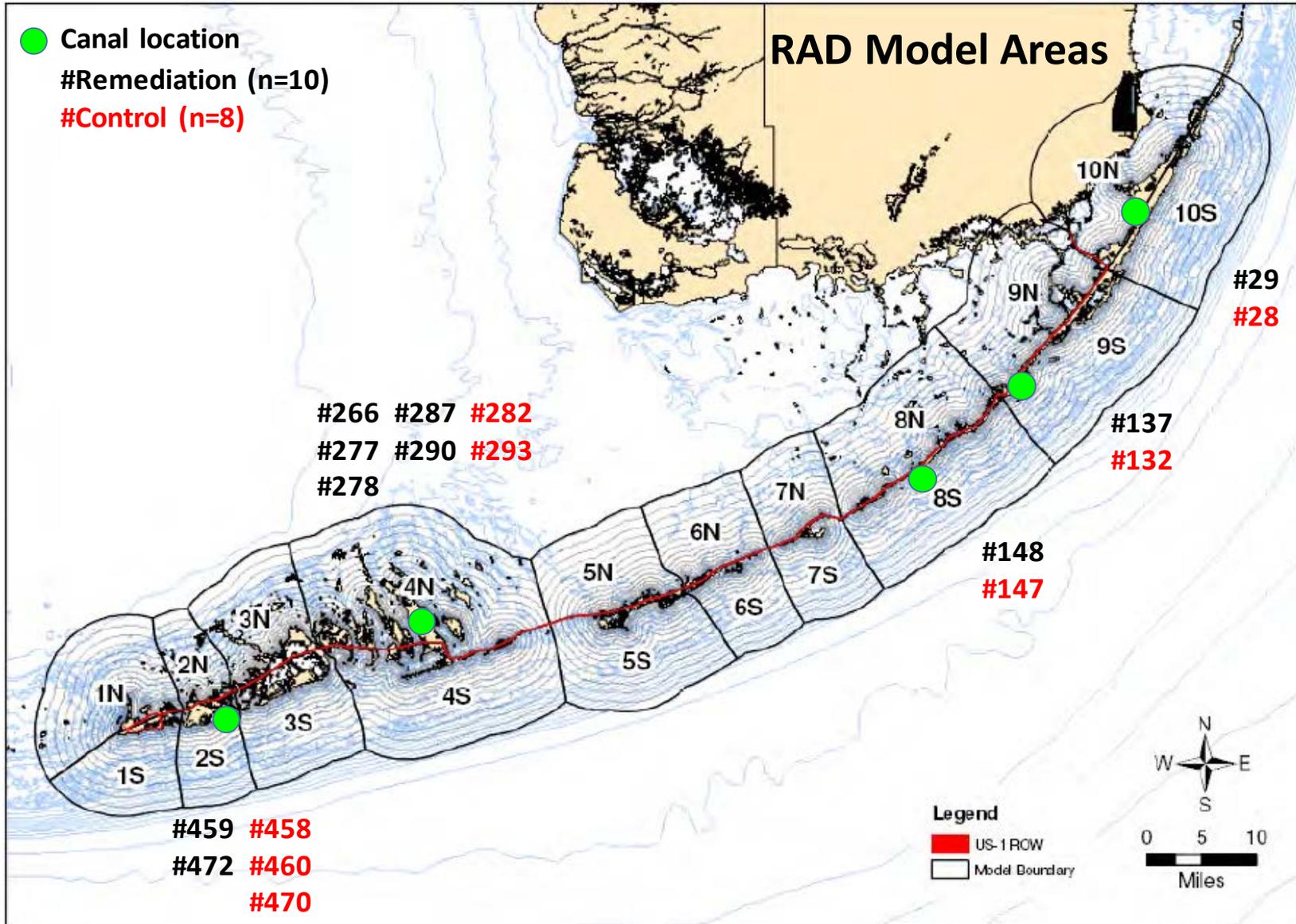
- % Dissolved Oxygen Saturation (*Rule 62-302.533, F.A.C.*)
- Nutrient concentration, especially Total Phosphorous and Total Nitrogen (FK RAD)

## Dissolved Oxygen water quality targets according to *Rule 62-302.533, F.A.C.*

**OBJECTIVES:** Monitor improvement and assess compliance  
Minimum DO saturation levels shall be as follows:

- 1. The daily average percent DO saturation shall not be below 42 percent saturation in more than 10 percent of the values***  
“A full day of diel data shall consist of 24 hours of measurements collected at a regular time interval of no longer than one hour.”
- 2. The seven-day average DO percent saturation shall not be below 51 percent more than once in any twelve week period***  
“To calculate a seven-day average DO percent saturation, there shall be a minimum of three full days of diel data collected within the seven-day period, .....with each sample measured at least four hours apart.”

# Nutrient concentration targets according to Keys RAD



## Water quality targets according to the FKRAD program

Project	Canal #	Model Zone	TP ( $\mu\text{g/l}$ )	TN ( $\mu\text{g/l}$ )
Backfilling	29	10N	8	324
Weed Barrier	137	9S	7	123
Culvert installation	472	2S	8	135
Weed Barrier	287	4N	12	221
Organic removal	290	4N	12	221
Weed Barrier / organic removal	266	4N	12	221
Culvert installation	277	4N	12	221
Weed Barrier	148	8S	8	124
Pumping	278	4N	12	221
Culvert installation	459	2S	8	135

## **WATER QUALITY MONITORING PROJECT FOR DEMONSTRATION OF CANAL REMEDIATION METHODS FLORIDA KEYS**

### **Implementation**

The execution of the project includes two phases:

- 1) Before remediation: Characterization Stage
- 2) After remediation: Tracking Recovery Trajectory Stage

## Demonstration canals included in this report



- **First project:** Backfilling at Canal #29 in Sexton Cove in Key Largo. Completed in July 2015.
- **Second project:** Culvert Installation to connect Canals #472 and #470, on Geiger Key. Completed in April 2015.
- **Third project:** Combined Organic Removal and Air Curtain Installation on Canal #266 at Drs. Arm and Avenue J in Big Pine Key. Completed in May 2016.

## Demonstration canals included in this report



- **Fourth project:** Organic Muck Removal Project on Canal #290 Avenue I on Big Pine Key. Completed in March 2016.
- **Fifth project:** Installation of a culvert under a roadway and private property connected two portions of Canal #277. Completed in May 2016.
- **Sixth project:** Air Curtain Weed Gate Installation for Canal #287 in Atlantic Estates on Big Pine Key. Completed June 2016.

# Canal #29. Remediation technology: Backfilling. Completed Jul-15

## %DO Saturation

**LEGEND**

- Above Target
- Below Target

			Pre-remediation		Post-remediation		
			31-Mar-14	16-Oct-14	4-Feb-16	28-Apr-16	
% Dissolved Oxygen Saturation	Surface water	29					
		Control 28					
	Bottom water	29					
		Control 28					

**Oxygenation has improved significantly in bottom waters of the remediated canal. Bottom DO declined in Aug 2016 due to storm Hermine.**

- Surface waters well oxygenated before and after remediation
- Surveys show increase %DO saturation in shallower new bottom waters after the canal's depth was risen from 35 feet to 8 feet
- Rain and wind during TS Hermine may have caused a drop in %DOSat



# Canal #29. Remediation technology: Backfilling. Completed Jul-15

## Nutrients

			Pre-remediation		Post-remediation	
			31-Mar-14	16-Oct-14	4-Feb-16	
Total Phosphorus	29	Surface water	Below Target	Above Target	Below Target	
	Control 28		Above Target	Above Target	Below Target	
	29	Bottom water	Below Target	Above Target	Below Target	
	Control 28		Above Target	Above Target	Below Target	
Total Nitrogen	29	Surface water	Above Target	Above Target	Above Target	
	Control 28		Above Target	Above Target	Above Target	
	29	Bottom water	Above Target	Above Target	Above Target	
	Control 28		Above Target	Above Target	Below Target	

### LEGEND

- Above Target
- Below Target

**TN has always been in compliance while TP still remains too high**

- Pre-remediation and first post-remediation surveys rendered TP concentrations out of compliance
- Surface and Bottom TN concentrations in compliance in all events before and after remediation

## Canal #472. Remediation technology: Culvert installation. Completed May-15 and was closed shortly after, unplugged May-16

		Pre-remediation		Post-remediation				
				Culvert open		Culvert closed	Culvert open	
		22-May-14	25-Oct-14	4-May-15	7-May-15	4-Aug-15	20-May-16	
% Dissolved Oxygen Saturation	<b>472</b>	Surface water	Green	Green	Green	Green	Green	Green
	Control 458		Green	Green	Green	Green	Green	Green
	Connection 470		White	White	White	Green	Green	Green
	<b>472</b>	Bottom water	Red	Red	Green	Green	Red	Red
	Control 458		Red	Red	Green	White	Green	Red
	Connection 470		White	White	White	White	Green	Green

**LEGEND**

Above Target

Below Target

**Mixed results. No definitive improvement trend for bottom waters after re-opening culvert**

- Surface waters well oxygenated during monitoring before and after remediation. Heavy seaweed build up observed in late May 2015
- %DO saturation increased in bottom waters of remediated canal when culvert was opened the first time indicating an enhancement of natural tidal flushing

# Canal #472. Remediation technology: Culvert installation. Completed May-15 and was closed shortly after, unplugged May-16

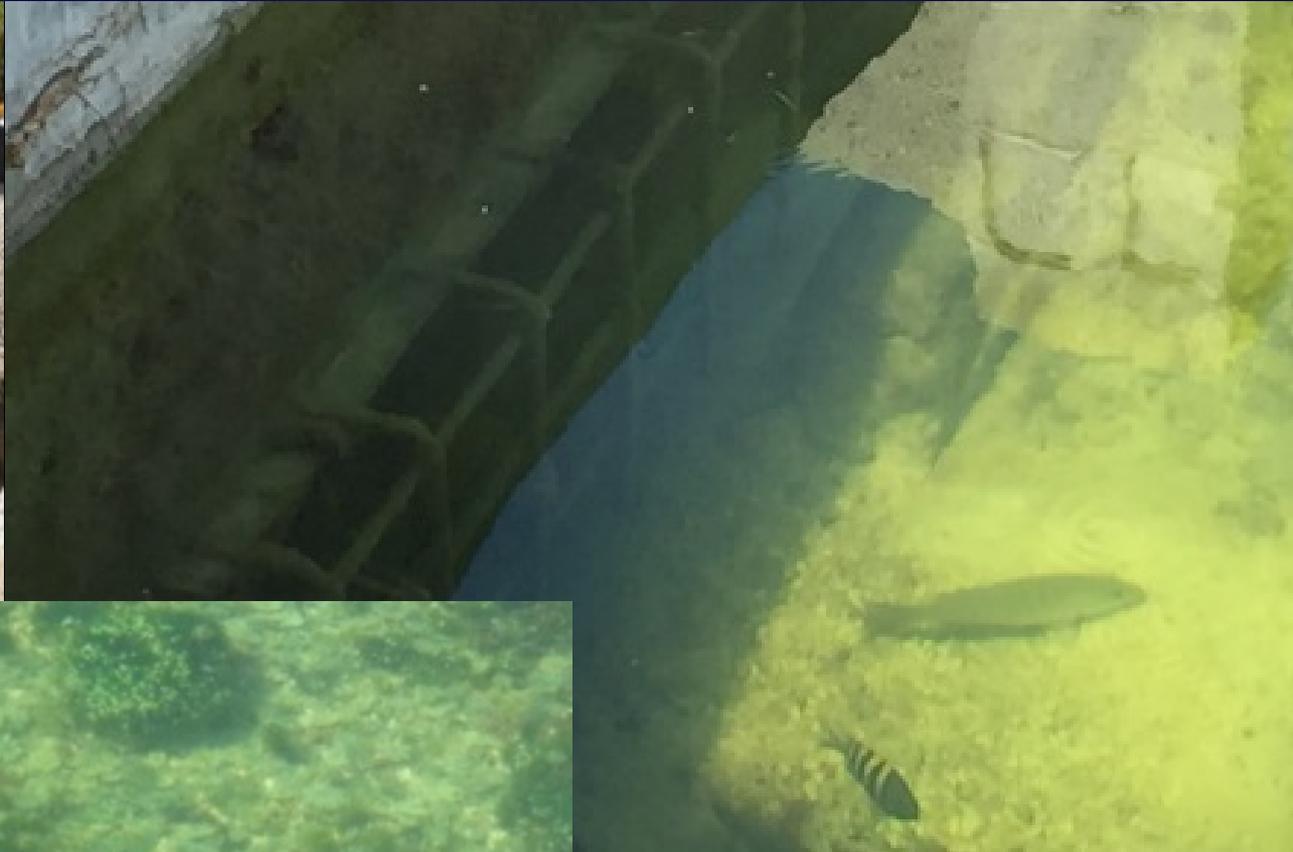
		Pre-remediation		Post-remediation			
				Culvert open		Culvert closed	Culvert open
		9-May-14	15-Oct-14	29-Apr-15	29-Jun-15	1-Aug-15	20-May-16
Total Phosphorus	472	Surface water	Below Target	Above Target	Below Target	Below Target	
	Control 458	Surface water	Below Target	Below Target	Below Target		
	Connection 470	Surface water			Below Target		
	472	Bottom water	Below Target	Above Target	Below Target	Below Target	
	Control 458	Bottom water	Below Target	Below Target	Below Target		
	Connection 470	Bottom water			Below Target		
Total Nitrogen	472	Surface water	Below Target	Below Target	Below Target		
	Control 458	Surface water	Below Target	Below Target	Below Target		
	Connection 470	Surface water			Below Target		
	472	Bottom water	Below Target	Below Target	Below Target	Below Target	
	Control 458	Bottom water	Below Target	Below Target	Below Target		
	Connection 470	Bottom water			Below Target		

**LEGEND**

- Above Target
- Below Target

**No definitive improvement trend yet.**  
**New survey will be performed during Sep 2016**

- Surface and Bottom TP concentrations out of compliance in most events before and after remediation
- Pre-remediation surveys rendered TN concentrations out of compliance



# Canal #266. Remediation technology: Weed barrier/organic removal. Completed May-2016

			Pre-remediation		Post-remediation
			7-May-14	14-Oct-14	21-Jun-16
% Dissolved Oxygen Saturation	266	Surface water	Below Target	Above Target	Below Target
	Control 293		Below Target	Above Target	Above Target
	266	Bottom water	Below Target	Below Target	Below Target
	Control 293		Below Target	Below Target	Below Target

**LEGEND**

- Above Target
- Below Target

**No improvement trend yet.  
New survey will be performed during Sep 2016**

- Pre and post-remediation surveys showed highly variable %DO saturation in surface waters
- Pre and post-remediation surveys rendered %DO saturation in bottom waters out of compliance

**Canal #266. Remediation technology: Weed barrier/organic removal.  
Completed May-2016**

			Pre-remediation		Post-remediation
Total Phosphorus	266	Surface water			
	Control 293				
	266	Bottom water			
	Control 293				
Total Nitrogen	266	Surface water			
	Control 293				
	266	Bottom water			
	Control 293				

LEGEND

-  Above Target
-  Below Target

**No data post-remediation available**

- Surface and Bottom waters rendered TP and TN concentrations out of compliance before remediation

## Canal #290. Remediation technology: Organic removal. Completed Mar-16.

			Pre-remediation			Post-remediation
			8-Jun-14	22-Sep-14	17-Aug-15	24-Jun-16
% Dissolved Oxygen Saturation	290	Surface water	Below Target	Below Target	Above Target	Below Target
	Control 293		Below Target	Above Target	Below Target	Above Target
	290	Bottom water	Below Target	Below Target	Below Target	Below Target
	Control 293		Below Target	Below Target	Below Target	Below Target

**LEGEND**

■ Above Target

■ Below Target

**Mixed results. No improvement observed yet.**

- Surface waters do not meet %DO saturation target either in most events during monitoring before or after remediation. Notice that an existing air curtain weed gate owned by the homeowners was reinstalled, but some seaweed has entered the remediated canal
- Vacuum dredging was used to remove 5 feet of organic muck. Following removal of the muck, a 6-inch sand layer was added to allow for benthic habitat proliferation

## Canal #290. Remediation technology: Organic removal. Completed Mar-16.

			Pre-remediation			Post-remediation
			7-May-14	14-Oct-14	24-Jun-15	
Total Phosphorus	290	Surface water				
	Control 293	Surface water				
	290	Bottom water				
	Control 293	Bottom water				
Total Nitrogen	290	Surface water				
	Control 293	Surface water				
	290	Bottom water				
	Control 293	Bottom water				

### LEGEND

- Above Target
- Below Target

**Remediation ended May 2016. Waiting for water chemistry test results**

- Surface and Bottom waters rendered TP and TN concentrations out of compliance before remediation
- Beginning of chemical analyses to occur 6 months after remediation.

# Canal #277. Remediation technology: Culvert installation. 20-Apr-2016

		Pre-remediation				Post-remediation	
		6-Jun-14	23-Sep-14	14-Aug-15	7-Feb-16	30-Jun-16	
% Dissolved Oxygen Saturation	<b>277</b>	Surface	Below Target	Below Target	Above Target	Above Target	Above Target
	Control 282	water	Below Target	Above Target	Above Target	Above Target	Below Target
	<b>277</b>	Bottom	Below Target	Below Target	Above Target	Above Target	Below Target
	Control 282	water	Below Target	Above Target	Below Target	Above Target	Below Target

**LEGEND**

- Above Target
- Below Target

**No clear improving trend yet. Perhaps too early to detect significant changes**

- Surface waters well oxygenated most of the time during monitoring before and after remediation. Water clarity with fish visible at the culvert entrance (MC, Jun 2016), although no differences in turbidity in S/B water has been observed after remediation
- Abundant blue-green algae mats floating on surface (#282) and abundant floating manatee grass present in canal #277
- %DO saturation in bottom waters of remediated canal remains below target values approx. 2 months after culvert was opened the first time

## Canal #277. Remediation technology: Culvert installation. 20-Apr-2016

			Pre-remediation				Post-remediation
			7-May-14	15-Oct-14	24-Jun-15	17-Feb-16	
Total Phosphorus	<b>277</b>	Surface water	Below Target	Below Target	Below Target	Above Target	
	Control 282		Below Target	Below Target	Below Target	Below Target	
	<b>277</b>	Bottom water	Below Target	Below Target	Below Target	Above Target	
	Control 282		Below Target	Below Target	Below Target	Below Target	
Total Nitrogen	<b>277</b>	Surface water	Below Target	Below Target	Below Target	Below Target	
	Control 282		Below Target	Below Target	Below Target	Below Target	
	<b>277</b>	Bottom water	Below Target	Below Target	Below Target	Below Target	
	Control 282		Below Target	Below Target	Below Target	Below Target	

### LEGEND

- Above Target
- Below Target

**Waiting for results from test to be performed on Sep 2016**

- Surface and Bottom TP concentrations out of compliance in most events before remediation
- Pre-remediation surveys rendered TN concentrations out of compliance

# Canal #287. Remediation technology: Weed barrier. Completed Jun-16

			Pre-remediation				Post-remediation
			7-May-14	14-Oct-14	24-Jun-15	18-Feb-16	21-Jun-16
% Dissolved Oxygen Saturation	287	Surface water	Green	Green	Green	Green	Green
	Control 293		Red	Green	Red	Green	Green
	287	Bottom water	Red	Red	Red	Red	Red
	Control 293		Red	Red	Green	Red	Red

**LEGEND**

Above Target

Below Target

**No clear improving trend yet. Perhaps too early to detect significant changes**

- Surface waters well oxygenated during monitoring before and after remediation.
- %DO saturation in bottom waters of remediated canal remains below target values two weeks after the installation of the air curtain weed gate. Lots of suspended organic debris, settled on floats and sondes

**Canal #287. Remediation technology: Weed barrier. Completed Jun-16**

			Pre-remediation				Post-remediation
			7-May-14	14-Oct-14	24-Jun-15	18-Feb-16	
Total Phosphorus	287	Surface water					
	Control 293						
	287	Bottom water					
	Control 293						
Total Nitrogen	287	Surface water					
	Control 293						
	287	Bottom water					
	Control 293						

**LEGEND**

- Above Target
- Below Target

**Waiting for results from test to be performed on Sep 2016**

- Surface and Bottom waters rendered TP and TN concentrations out of compliance before remediation in both, control and treated canal



## Tentative work schedule

Project	Canal #	<i>FKC-07</i>
Backfilling	29	Sep-16 D&N S&B
CONTROL	28	Sep-16 D&N S&B
Weed Barrier	137	Sep-16 D&N S&B
CONTROL	132	Sep-16 D&N S&B
Culvert installation	472	Sep-16 D&N S&B
Connection to 472-NEW	470	Sep-16 D&N S&B
CONTROL	458	Sep-16 D&N S&B
Air Curtain Weed Gate	287	Sep-16 D&N S&B
Organic removal (air curtain by homeowners)	290	Sep-16 D&N S&B
Weed Barrier / organic removal	266	Sep-16 D&N S&B
CONTROL	293	Sep-16 D&N S&B
Culvert installation	277	Sep-16 D&N S&B
CONTROL	282	Sep-16 D&N S&B

**Legend:** D (3-day Diels), S&B (Surface and Bottom water), N (Nutrient analysis)

## Tentative deliverables schedule

Task	Due date following work execution	Deliverable
Quarterly monitoring FKC-06	90 days	Progress report
Reporting	90 days of the period end date	Bi-annual report
Quarterly monitoring FKC-07	90 days	Progress report
Quarterly monitoring FKC-08	90 days	Progress report
Quarterly monitoring FKC-09	90 days	Progress report
Reporting	90 days of the project period end date	Final report