University of Idaho
Boise
CENTER FOR ECOHYDRAULICS RESEARCH

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Design Fabrication Services,
Sensors, Fixtures, Materials, Prototyping
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ISF STAKE MANUAL

TABLE OF CONTENTS

A.   ABSTRACT:

The Center for Ecohydraulics at University of Idaho has an ongoing program to provide cost effective methods for collecting field data on streambed behavior. The Idaho Streams Flux Stake is a microcontroller based device that can be used to collect long term streambed data while allowing for intermediate data retrieval without disturbing the long term data collection. While there are many data collection and retrieval ideas currently available in the literature, The ISF stake is a field ready device that can be supplied or built from open-source documentation. The ISF stake design utilizes common IOT electronics, inexpensive mechanical components, and open-source control software.

B.   INTRODUCTION:

The ISF stake is used to collect temperature data at multiple depths below the streambed surface. The stake package is a 1 3/8" diameter sealed PVC stake. It is embedded into the streambed with pressure or temperature sensors at multiple depths, potentially with the top sensor above the streambed. Figure B.1 shows a ISF stake installation. A LiIon cell and onboard memory is utilized to power data collection over multiple seasons without intervention. In addition, data, either intermediate or final data, can be collected from an ISF stake utilizing Wifi data transfer to an Android phone app. Intermediate data transfer is accomplished without removing or disturbing the installed ISF stake. To accomplish the two functions described, the stake consists of a section containing multiple sensors, and a section containing a microcontroller, LiIon cell, Wifi capability, Wifi switch and an on/off switch. Figure B.2 highlights the various functional areas of the ISF stake. Figure B.3 is a screenshot of the data retrieval phone app. Figure B.4 shows part of the raw data file ready for further processing. The University of Idaho ISF stake design system provides a robust solution to study streambed behavior.
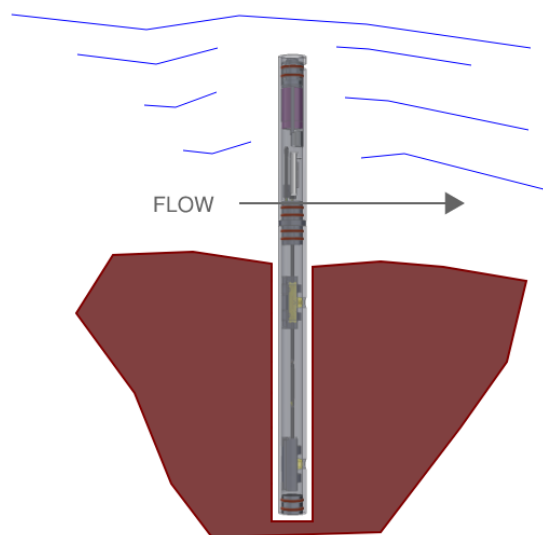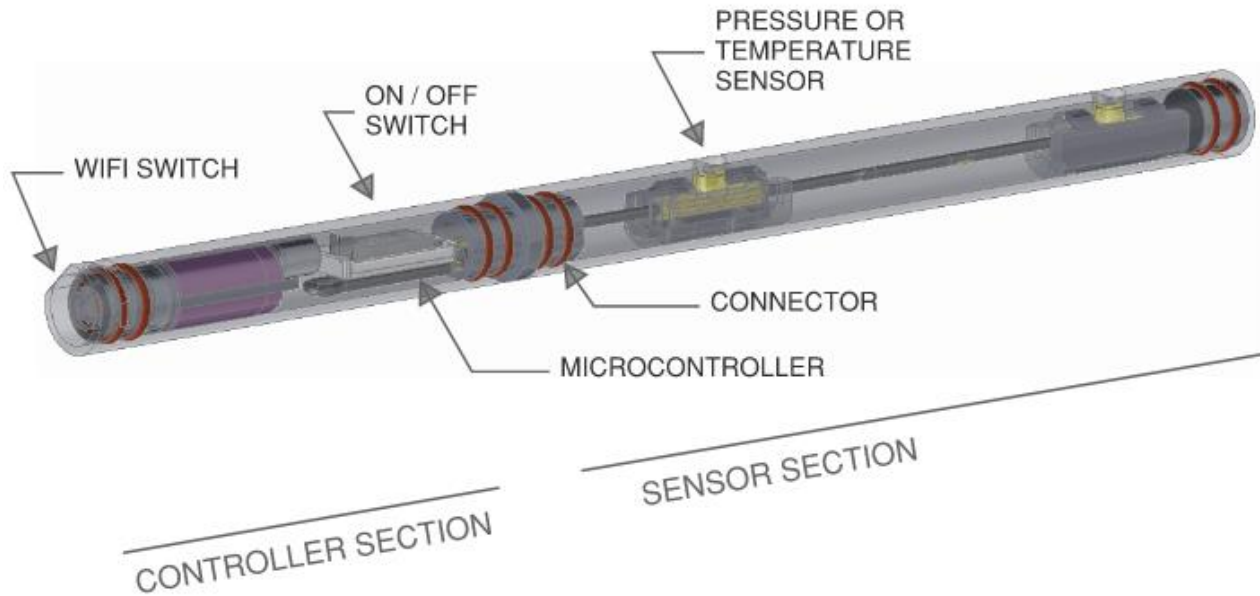

fig B.1

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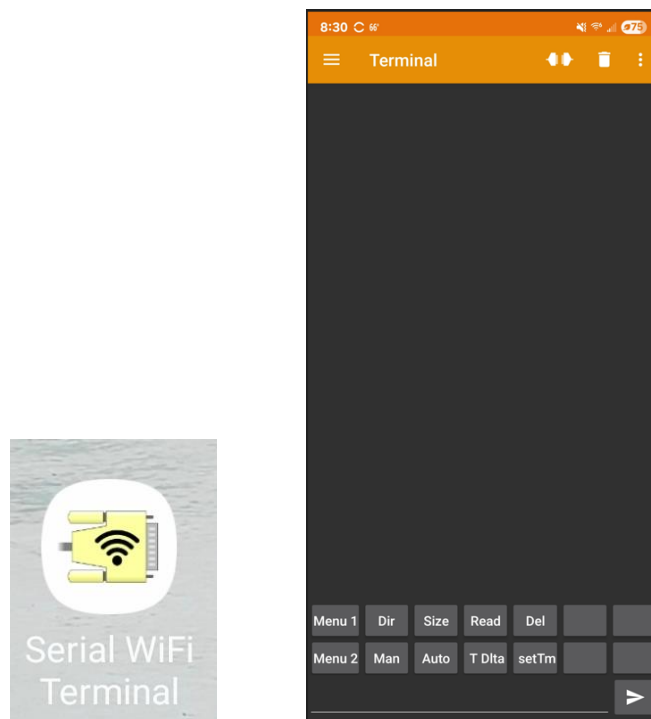208 364 4991
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fig B.2

fig B.3


```
2023-06-09, 03:14:37, 21.56,21.56^M
2023-06-09, 03:15:37, 21.56,21.56^M
2023-06-09, 03:16:37, 21.56,21.50^M
2023-06-09, 03:17:37, 21.56,21.50^M
2023-06-09, 03:18:37, 21.50,21.50^M
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2023-06-09, 03:20:37, 21.50,21.50^M
2023-06-09, 03:21:37, 21.50,21.50^M
2023-06-09, 03:22:37, 21.50,21.44^M
2023-06-09, 03:23:37, 21.50,21.50^M
```

fig B.4

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C.   THEORY OF OPERATION:

The ISF stake utilizes a custom microcontroller application to interact with sensors and a Android app to collect store and retrieve data. There are three distinct functional phases to understand, system initialization, data collection and data retrieval. Figure C.1 describes the firmware operation during the system initialization phase. Figure C.2 describes the system operation during the data collection phase. Figure C.3 describes the system operation during the data retrieval phase.

The system initialization phase sets a start date, sets up a data file, determines what sensors are present, sets the data collection cycle, and sets up Wifi parameters.

The data collection phase is a continuous loop that collects sensor data, opens the data file, adds current data to the file and then puts the system to sleep, repeating on a 15 minute data collection cycle.

The data retrieval phase is initiated with an ISF Wifi wand. The wand is used to activate a switch at the top of the ISF stake. Once this switch is activated the software interrupts the data collection phase, whether during active data collection, or sleep time, and initiates Wifi, then responds to commands that are sent by the Android app. The app commands are used to retrieve data from the ISF stake and store the data on the phone as a .txt file.
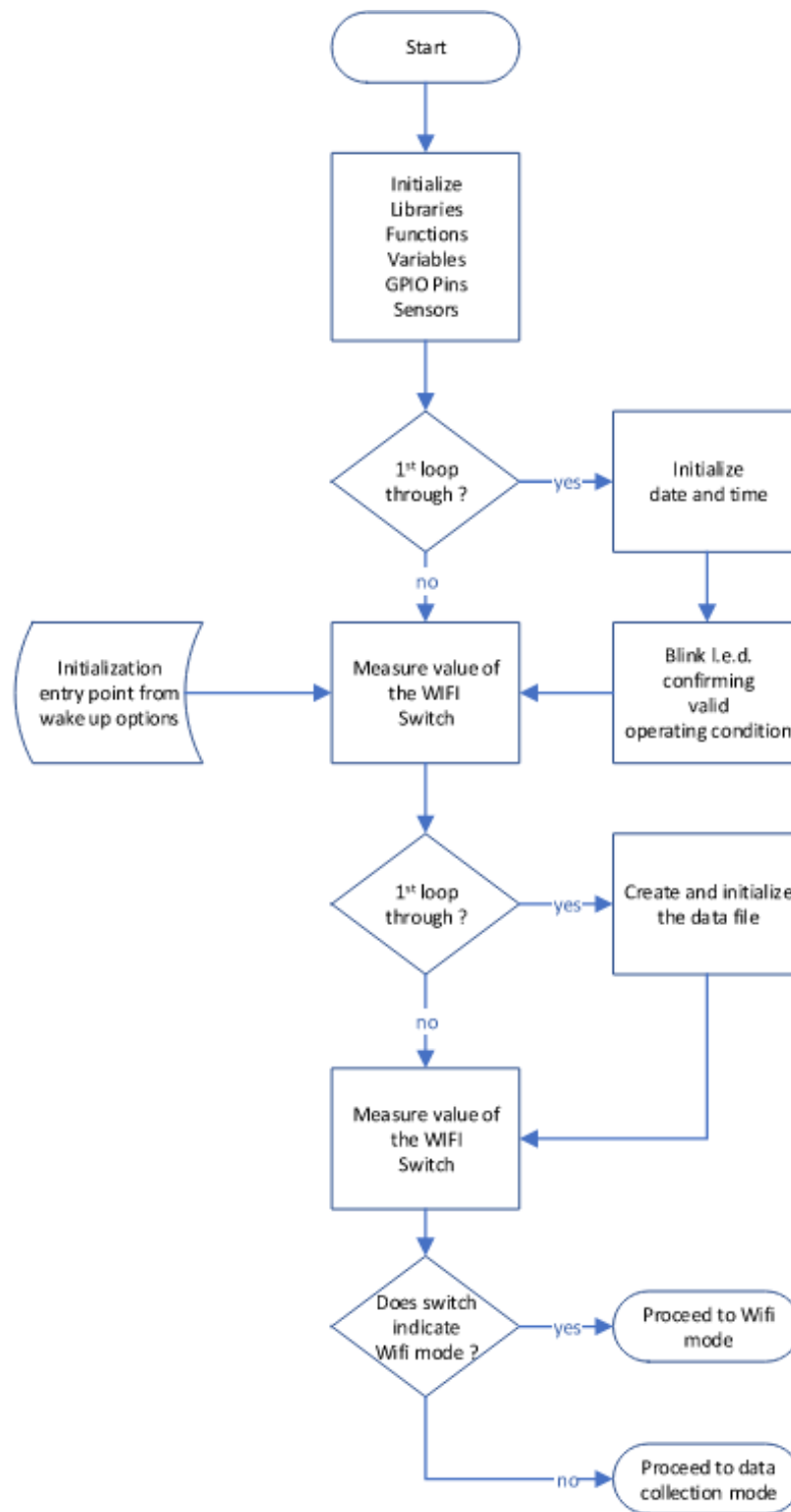   **For detailed instructions on operating the phone app, see Android Phone App instructions.**

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fig C.1

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fig C.2

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fig C.3

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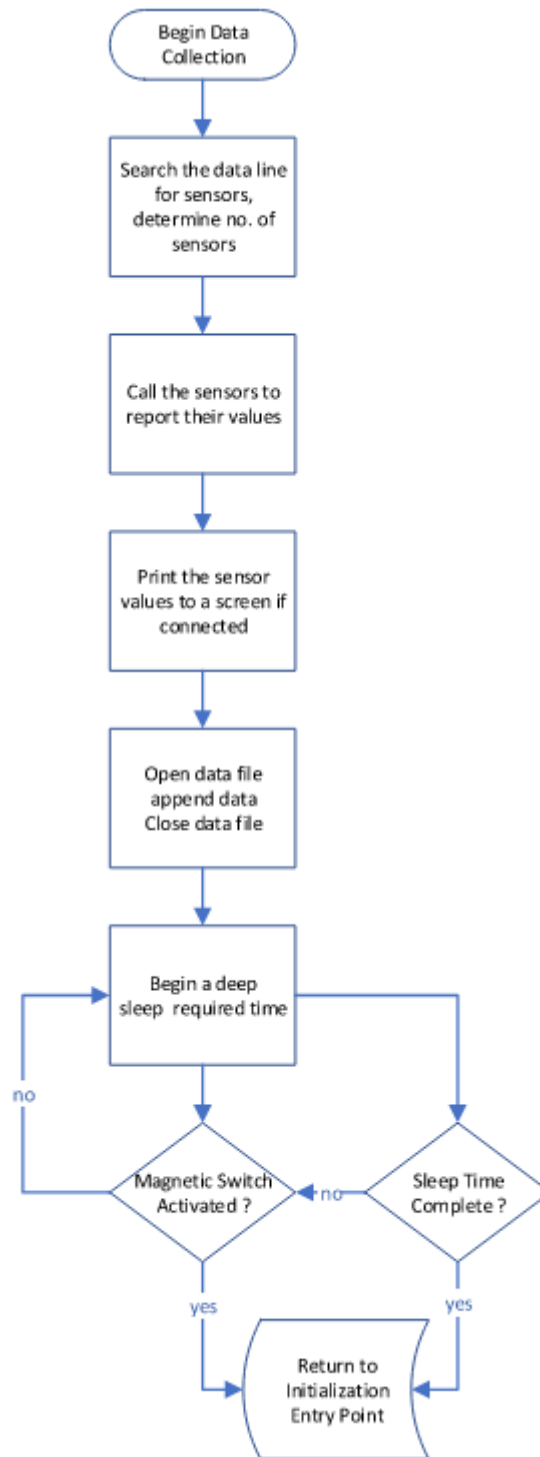Sensors, Fixtures, Materials, Prototyping
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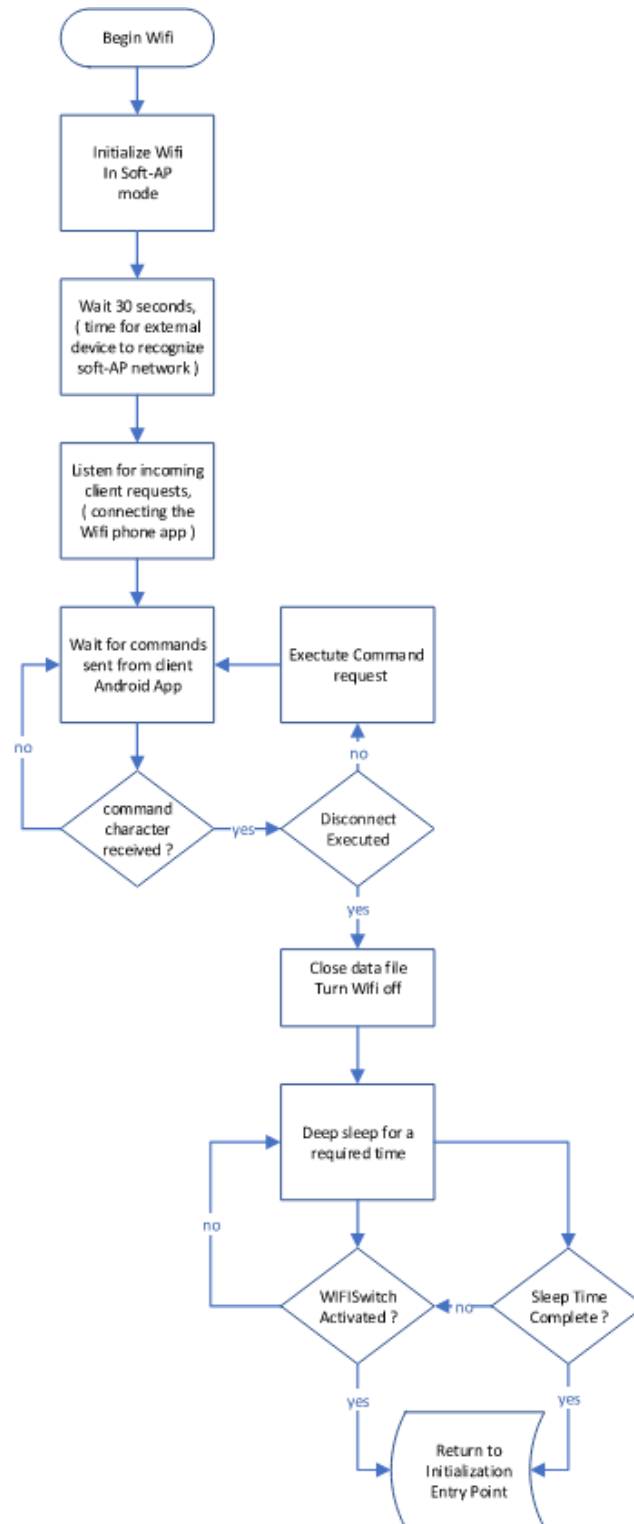
D.   OPERATING PROCEDURE:

An area to be studied has been identified and ISF stakes need to be installed into a local streambed. There are three main components needed to begin field data collection; a streambed drill tool, a ISF Wifi wand, ISF stakes, and the installed ISF Android app.

1. STREAMBED PREPARATION: Describe drill and embed procedure.

2. ISF STAKE INSTALLATION:

   a.   Verify the stake is powered on by pressing the Wifi switch at the top of the ISF stake. While there is no visual user feedback that the stake is on or off, checking for Wifi connectivity serves as the on/off feedback. Completing a Wifi connection at this time verifies the stake is powered on and operating correctly. See the Wifi connection procedure in the data retrieval section. Note, do not power the stake on while it is under water.

   b.   Once the installation hole is drilled place the stake into the hole with the controller section facing up. Also rotate the ISF stake so the sensor windows are facing downstream.

   c.   Replace as much streambed material around the stake as is practical, assuring the stake is held securely in place in the streambed.

3. ISF STAKE DATA RETRIEVAL

   At any point during the field study intermediate data can be collected for further processing. After intermediate data is retrieved the onboard data file can either be left to continue, or deleted, thereby commanding the creation of a new onboard data file. Wifi is used to retrieve data from an installed ISF stake. The onboard Wifi is only activated for data retrieval and at no other time so that battery life can be optimized. The ISF Wifi wand is the tool used to activate the onboard Wifi. The wand activates the Wifi switch on the ISF stake.

   a.   Utilize the phone intended for data retrieval to connect to the ISF stake. Make sure to use the phone settings to turn off any network specific autoconnect options. Assure that Wifi is active on the phone. Have the Wifi settings open on the phone, ready to look for the "Idahostreams" network to appear. Have the Serial Wifi open on the phone, ready to "connect".

   b.   Once an installed ISF stake is located, place the ISF Wifi wand over the stake and lower until it reaches a stop. Now press the wand down, feeling the switch on the top of the stake depress. The onboard Wifi is now being activated, and then will wait for 30 seconds to receive a connection request from the Android app.

   c.   On the phone Wifi settings screen watch for the "Idahostreams" network. Note the ISF stake Wifi does not require any login or password. Once the phone settings shows that the phone sees the "Idahostreams" network, open the ISF Wifi Serial Terminal App. Press the "Wifi connect" icon, and if successful, the connection will be confirmed in the message section of the app. If the app message does not show connected, it will show a not connected error. If the connection is unsuccessful, repeat steps b. and c. here.

d. With the ISF stake and the data retieval phone connected through Wifi, data can be transferred from the ISF stake to the phone and saved as a .txt file. There are many possible steps that can be taken here. It is recommended to become familiar with the app to develop a preferred workflow prior to attempting field based data transfer. The steps outlined here are the minimum key steps in the process.

      i. Press the "Trash Can" icon: This clears the screen prior to data download, as the "save" command will save all text in the active screen.

      ii. Press "Read": The entire contents of the data file will be read from the ISF stake to the phone screen. This may take up to a minute to complete.

      iii. Press the " 3 dot more" icon, then "data", then "save": This will save the current screen contents, including data that has scrolled past the visible screen to a .txt file on the phone.

      iv. Press the "connect" icon: This disconnects the ISF stake and returns it to the data collection mode. Note, feedback that this has happened is that the phone app will show disconnected from the Idahostreams network.

For a detailed description of the phone app see the Phone app instructions.
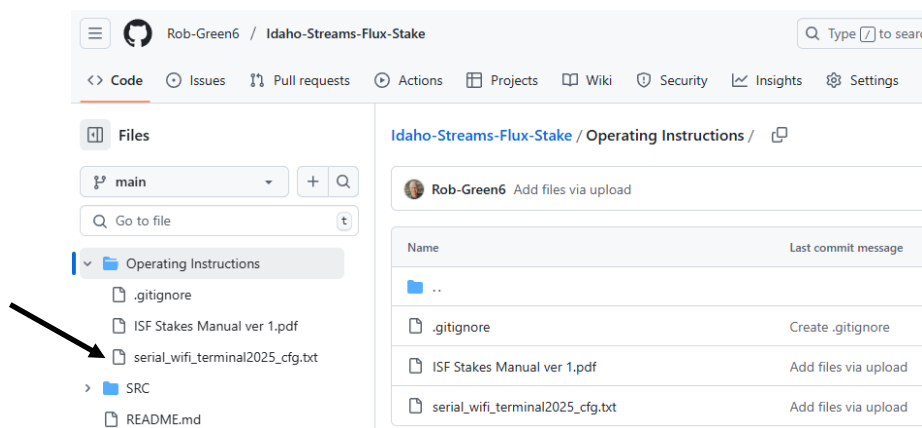
4. ISF STAKE REMOVAL FROM STREAMBED

a. Loosen the streambed around the ISF stake. Using a steel bar hammered into the streambed aroud the stake can be good method to complete this task. Rebar sharpened at one end can be a good inexpensive tool for this step. Hint, if consistent downstream orientation of the sensor windows is practiced during installation, a rod can be hammered down touching the upstream side of the ISF stake, helping loosen the stake.

b. Pull up on the sensor section of the ISF stake. Note the stake is comprised of two sections held together with a connector. Do not pull the stake up holding the upper controller section as the two sections may pull apart.

c. Once the stake is out, take some effort to replace the streambed materials.

d. Only power the ISF stake off after bringing the stake to dry land. The power switch is water proof, though like a water resistant watch, activating buttons during wet, or under water is not recommended.

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E.   ISF STAKE MAINTENANCE

The ISF stake is intended to serve long term installed over multiple seansons. Once an installation is complete and the stake returned to a lab, the stake is serviceable to prepare it for another installation. The device consists of two main sections, controller section and sensor section. Items to review or replace are discussed below. The first step into maintenance is to disassemble the two sections. Firmly hold each section and pull apart. Rotating the sections slightly is helpful, however do not rotate more than 30 degrees. Once the sections are apart, disconnect the wiring connector.

1.   SENSOR SECTION MAINTENANCE: The sensors are digital with onboard memory and a unique serial number encoded. They are calibrated at the factory and do not need service. In the ISF stakes, the sensors are waterproofed in a polyurethane molding. The polyurethane molding is assembled into a spring loaded housing to assure proper placement in the stake. Water leaks is the item to review in the sensor section.

a.   Generally inspect the inside of the sensor section stake. Look for debris or signs of moisture.

b.   Inspect the o-rings on the connector for cuts or abrasion.

c.   Inspect each sensor exit hole. There should be no missing patches of epoxy

d.   If any items show damage or signs of leakage, either self repair can be undertaken, or contact the University of Idaho CER group for spare parts.

2.   CONTROLLER SECTION MAINTENANCE

a.   Generally inpspect the inside of the controller section of the stake. Look for debris or moisture.

b.   Inspect the o-rings on the connector for cuts or abrasion.

c.   Verify proper electrical working order by activating the power switch to turn on the controller. If the system is in good condition, the controller will blink inside the stake for a couple seconds. Note, the led that blinks is not bright, best to perfrom this check in low light.

d.   If any items show damage or signs of leakage, either self repair can be undertaken, or contact the University of Idaho CER group for spare parts.

3.   BATTERY REPLACEMENT Battery life is highly dependant on multiple factors. Some are, temperature of the environgment, amount of time using Wifi, frequency of data collection and time in the field, as well as shelf life prior to use. If the stake is intended for reuse, it is recommended to replace the battery. The batteries are LiIon high energy cells intended for a low current draw. To obtain the long stake service life a specific cell has been implemented that requires effort to replace. There are multiple options to have a new battery ready for ISF stake reuse.

a.   Return the contols section to University of Idaho for battery replacement.

b.   Purchase a cell directly and complete a self replacment. Note, this requires electrical knowledge and skills. It is not recommended.

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F.   ISF PHONE APP MANUAL The app is open source android app available at the Goolge Play Store
The app is "**Serial WiFi Terminal**" by Kai Morich

1.   PHONE APP SET UP The app is available for Android devices that have Wifi. The app is customized for the
ISF Stake project. Download the app to the Android field device or phone and install.

2.   All customization menus and settings are contained in a configuration file. The configuration file is available
from Github @ Rob-Green6. It is "serial_wifi_terminalXXXX_cfg.txt". To download the config file, right
click the file in the left hand "file tree window", then click "save as".

The direct link to the Github pages is:
https://github.com/Rob-Green6/Idaho-Streams-Flux-Stake/tree/main/Operating%20Instructions

3.   Import the ISF Stake configuration file to the app using the workflow shown in fig F.1. At the import action,
navigate to where the config file is stored on the device, and select it. Use the app to become familiar and
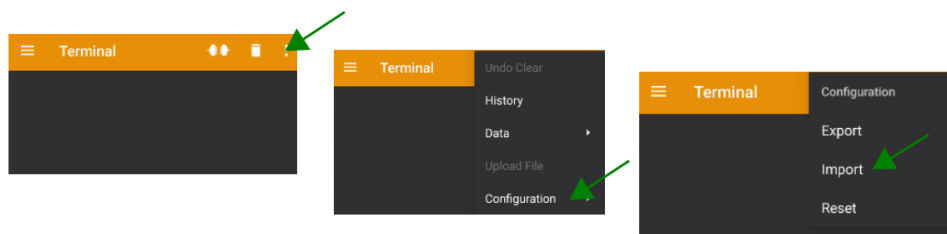comfortable with it prior to using it in the field.

fig F.1

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4. DATA RETRIEVAL WITH PHONE APP The functions built into the app approximate simple operating system commands. The app commands are acuated by pressing one of the menu keys. This only sends a letter to the ISF stake. The ISF stake interprets the letter received and executes a branch of code. If data is taken at long intervals, the amount of onboard data is enough to serve for multiple seasons of uninterupted data collection. Of course data can be retrieved at multiple intermediate periods. Hence there are enough functions available on the app to perform basic file management. An initial recommended work flow is listed here. The phone app commands are shown and described in fig F.2 and F.3.

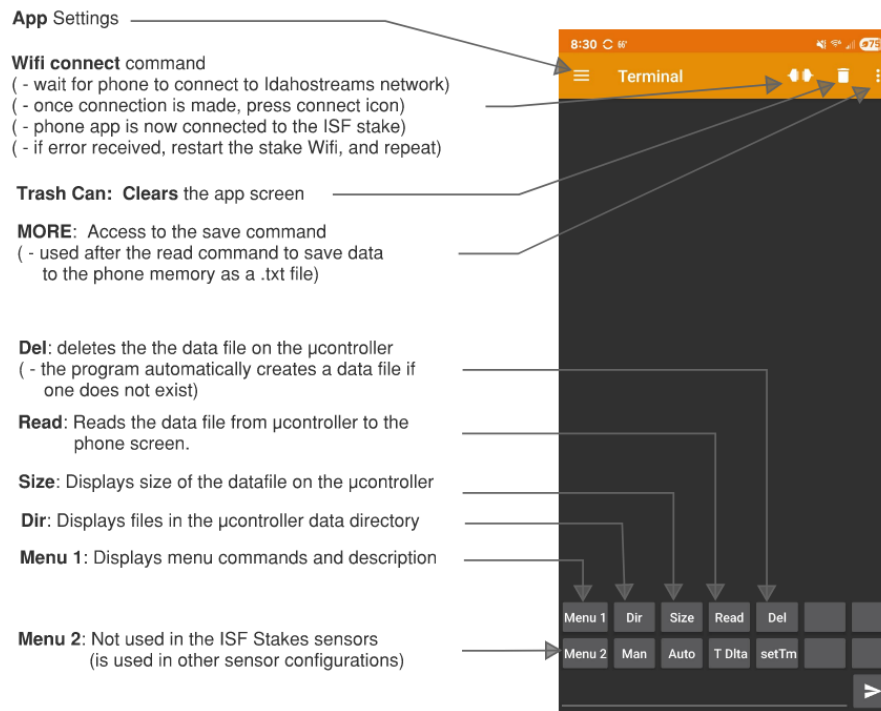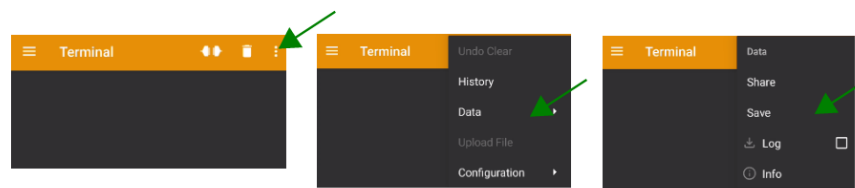|		
a.	Wifi connect icon	- to initiate connection
b.	Dir command	- to see existing file name
c.	Size command	- to see file size
d.	Trash can	- to clear the screen
e.	Read	- to read the data from the ISF stake to the phone
f.	More	- access save command
g.	Save	- saves .txt file to the data retrieval device
h.	Trash can	- to clear the screen
i.	Del	- to delete the file on the u-controller
j.	Wifi connect icon	- to disconnect from the state Wifi network

fig F.2

fig F.3