GEORGIA DOT RESEARCH PROJECT RP 20-23

FINAL REPORT

DEVELOPMENT OF AN APPLE APP FOR GDOT AASHTOWARE PROJECT

OFFICE OF PERFORMANCE-BASED MANAGEMENT AND RESEARCH

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16. Abstract

GDOT AASHTOWare is currently used to gather information about the sample data, which includes all the details of the samples, such as the basic sample data, contract information, testing status, and results. GDOT wants a mobile app that allows the user to create a new sample, enter the basic sample information on the mobile phone, and send this to AASHTOWare. This project creates a mobile app to gather this information and also a new labeling technology for concrete samples called CTAG. CTAG allows fresh concrete samples to be labeled with a barcode that can travel with the cylinder through the life of the testing. The mobile app developed on this project can use the phone's camera as a barcode scanner to create samples, save field measurements, and track the chain of custody of the samples. The app can also show information from AASHTOWare. This system of using the app and the CTAG together will help GDOT engineers with archiving, tracking, and sharing the concrete sample data in the field.

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GDOT Research Project RP 20-23

Final Report

DEVELOPMENT OF AN APPLE APP FOR GDOT AASHTOWARE PROJECT

By

Qinang Hu, Ph.D.
Carson Scantling
Aryen King
Jake LeFlore
Tyler Ley, Ph.D., P.E

Oklahoma State University

Contract with
Georgia Department of Transportation

In cooperation with

U.S. Department of Transportation
Federal Highway Administration

April 2022

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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EXECUTIVE SUMMARY

This document describes the development of a bar code based concrete sample management app for the Apple operating system that will interface with AASHTOWare.

GDOT is using AASHTOWare to gather information about the samples measured in the field. This includes the basic sample data, contract info, testing status, and testing results. GDOT wants a mobile app that can allow the user to create a new sample and enter the basic sample information on an Apple based mobile phone. The app can also accept a sample at a destination lab and allow sample information to be viewed on the app. This app should also work with bar codes used to label and track the cylinders provided by a CTAG (concrete tag).

The CTAG is a specialized label that was developed at Oklahoma State University. A CTAG is a label that places a barcode on the inside and outside of a concrete cylinder mold. The barcode on both samples matches and can be scanned with an app. The barcode goes inside the mold and has adhesive on one side and fibers on the other. The adhesive is used to stick the tag to the mold and hold it in place until the mold is filled with concrete. Wet concrete is added to the mold and after it has hardened, then it will bond to the fibers on the CTAG. When the concrete is removed from the mold the tag stays embedded in the surface of the cylinder. The CTAG has a low profile and will not impact the performance of the concrete and will stay bonded on the surface of the sample until it is tested.

This document will outline the structure and final framework of the Apple app created for GDOT. This document follows the software Design Document format provided by GDOT IT.

CHAPTER 1. INTRODUCTION

BACKGROUND

Samples of concrete need to be taken at regular intervals to monitor the quality. It is common for hardened samples to be made for strength testing. These samples must be labeled during creation, transported to a testing lab, demolded, labeled again, tested at the correct date, and then the data must be uploaded to AASHTOWare. Every sample is given a unique label to link the project, time, location, and test results. This process is time consuming and is prone to errors from lost samples or mislabeled samples.

This is a typical inventory management issue that the retail industry has dealt with by using barcodes and portable scanners. A barcode allows the identity and the associated information to be tracked immediately. This work aims to use unique labels for the concrete samples so that their identity and information can be organized and tracked. The CTAG (concrete tag) provides a matching label on the surface of the mold and also on the surface of the concrete. The CTAG uses a fabric-like surface that is embedded in the fresh concrete to permanently attach the barcode to the surface of the concrete sample. A matching barcode is used on the surface of the mold. These barcodes can be scanned with the developed app to identify the sample and track the sample location, just as a cashier scans the barcode on a product to show the name and the price of an item at a grocery store.

To make this usable by GDOT, a system is needed to scan a sample and either add it to a database or search the database for more information. A mobile phone application can make this possible as it can use the phone's camera as the barcode scanner, GDOT forces already have an issued cell phone, and the phone can provide the computational power to search through a large volume of

data. It can also connect to the internet to send and retrieve information from a database. This app will allow engineers to track the concrete sample and work with the data quickly on their phones. This system can better track samples, reduce human errors, save time for data collection, reduces paper and so improves the sustainability efforts of GDOT, and provides more information to GDOT forces to provide timely decisions.

SYSTEM OVERVIEW

An Apple mobile phone application uses the phone's camera as a barcode scanner to create samples, save field measurements, and track the chain of custody of the samples. These samples are labeled with the CTAG barcode code system on the outside of the mold and also on the surface of the hardened concrete. The app can also show sample information that will be included in AASHTOWare. Integrating this system with CTAG will allow GDOT to track the concrete sample and work with the data quickly on their phones. It can bring benefits to GDOT in the following ways:

- Reduces the workload of concrete sampling in the field and material testing in the lab
- Tracks the sample information by scanning the barcode with the camera on a mobile phone,
- Captures sample information and testing data and allows it to be updated and shared with others,
- Avoids the risk of miscommunication of sample labeling as every sample has a unique barcode permanently attached.
- Reduces paper usage and improves the sustainability of GDOT's efforts

GOALS AND OBJECTIVES

This work aims to create an Apple app that can link and work with the data for concrete samples to AASHTOWare Project (AWP). The app has been developed to meet the listed technical

requirements from GDOT for form 319:

- The app will use the GDOT Active Directory for user authentication.
- The app will provide offline mode capabilities when it is not connected to the internet.
- The app will be generalized to capture Sample Details, accept a sample at a Destination Lab, and display sample information including details such as Destination Labs, Lab Unit, Test Assigned, and Test Status.
- Fields captured are CTAG Number, Sample ID, Sample Date, Sample Type, Acceptance Method, and material information.
- The app will check if the lookup list is up to date using the application program interface (API). If not, it should download the differences and update the device's local database accordingly.
- Data for the material and sample type will use dropdown lists provided by GDOT AASHTOWare services.
- Offline Mode will allow sample creation with basic information i.e. CTAG number, sample ID, and sample date. This information will be stored locally on the device and will synchronize with GDOT AASHTOWare Data Services when the device is online on the network.
- Provide the ability to accept samples at destination labs.
- The mobile app needs to adhere to GDOT development & security standards.
- The GDOT logo will be included for branding.
- A user manual and training video will be provided.

CHAPTER 2. LEVEL DESIGNS

HIGH-LEVEL DESIGN

The dependencies of the interface systems are shown in Figure 1. In this project, GDOT provided the AASHTOWare API interface to allow the app to upload and retrieve the sample data from the GDOT AASHTOWare data system. The mobile app can interact with the API interfaces using Json Web Tokens (JWT) for sending a request and receiving the responses from the API. This document will be focused on the design of the mobile app.

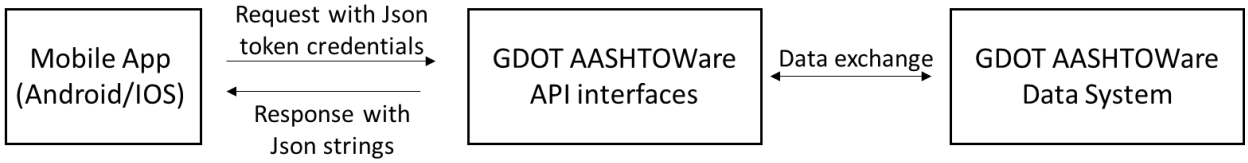

Figure 1. Flow Diagram. The dependencies of the interfaces.

USER INTERFACE

An overview of the workflow of the app's user interface is shown in Figure 2. This app has seven major screens which are inter-connected and centered around Sample List Screen. The user can navigate through the app by clicking the buttons on the Sample List Screen as the home screen. The details of the workflow and the interaction between the screen will be discussed in the following sub-sections.

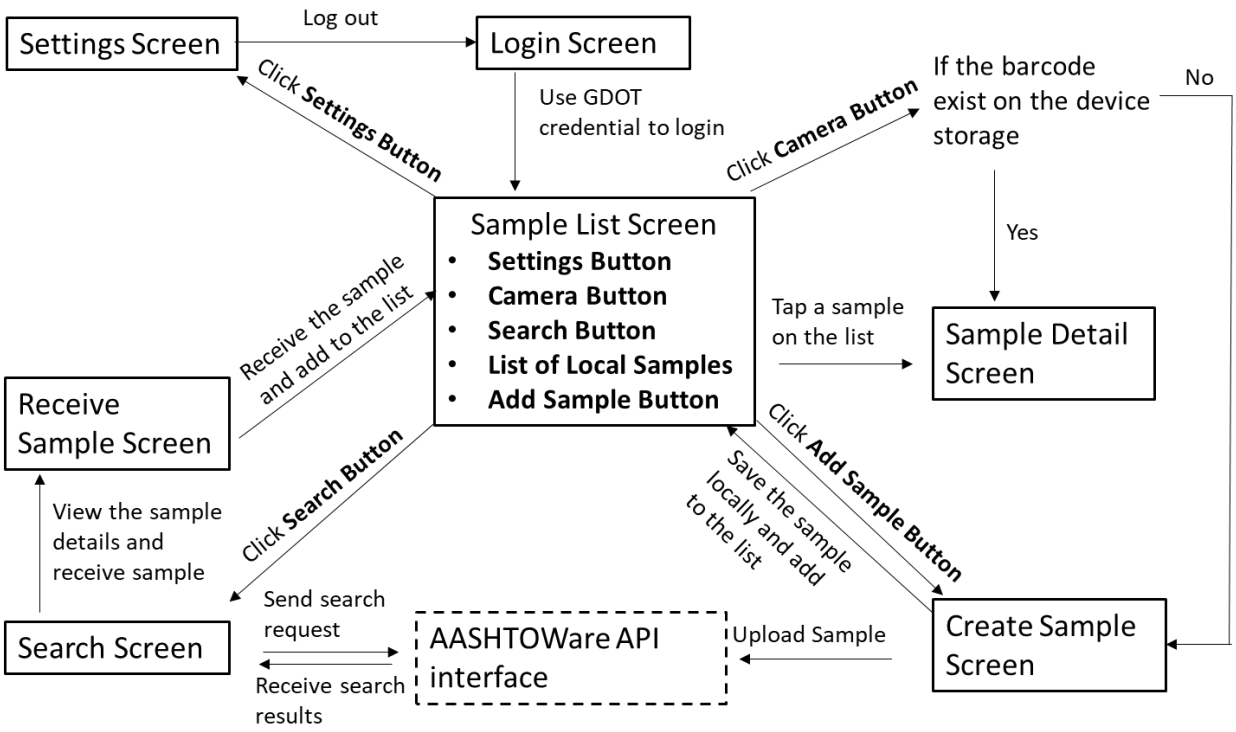

Figure 2. Flow Diagram. The overview of the workflow of the app's UI

LOG IN SCREEN

An example of the login screen is shown in Figure 3. The user can type in the ID and password of his/her AASHTOWare credentials to log in. The app will send a request to the API to verify and receive the role(s) from the API. Depending on the role(s), the user will gain different authority to access the screens of the app. Table 1 shows the different roles of the mobile user and the screen they have access to. A "Sampler" can participate in all activities but they cannot receive samples for testing. The "Tester" has access to all activities but they cannot create a sample. The "Administrator" has the access to all the activities.

Table 1 – Overview of the different users and the activities that they have access to.

Activity	*Sampler*	*Tester*	*Administrator*
Login	Yes	Yes	Yes
Sample Creation	Yes	**No**	Yes
Sample Listing	Yes	Yes	Yes
Sample Detail	Yes	Yes	Yes
Receive Sample	**No**	Yes	Yes
Settings	Yes	Yes	Yes
Search	Yes	Yes	Yes

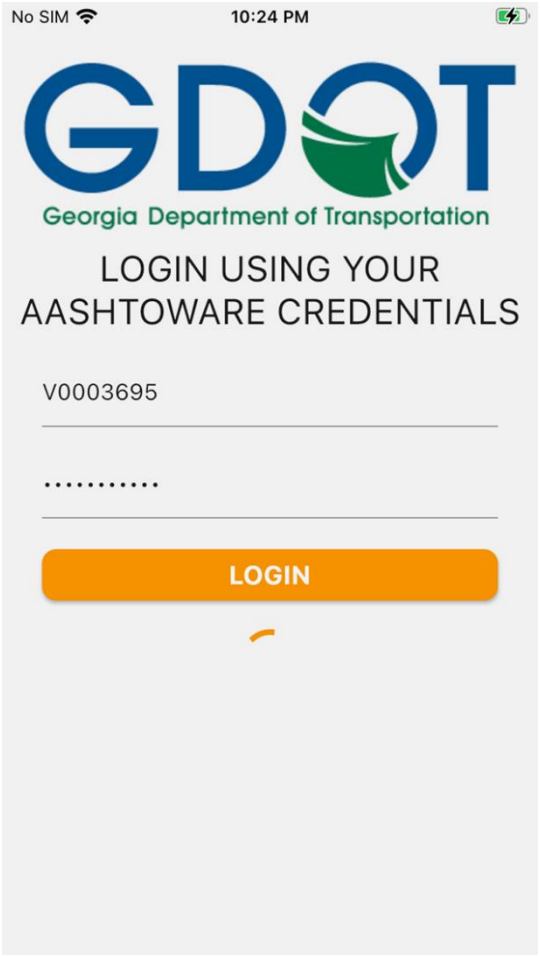

Figure 3. An example of the log in screen.

SAMPLE LISTING SCREEN

Once the user is logged in, the user will be first taken to the Sample Listing screen as shown in Figure 4. The app will automatically check if there are any updates from the API. Once the updates are completed, the screen will list the samples saved locally on the mobile device. The user can navigate to other screens by clicking the buttons. The functions of these buttons are

shown below.

- Setting button- navigate to the Setting screen
- Camera button- activate the camera as a barcodes scanner to scan a barcode. If the barcode exists in the device storage, the user will navigate to Sample Detail Screen. If it does not exist, the user will navigate to the Sample Creation screen
- Search button- navigate to the Search screen.
- Add sample button- navigate to Sample Creation screen.
- List of local samples - navigate to the Sample Detail screen.
- Delete button- delete the sample from the list.

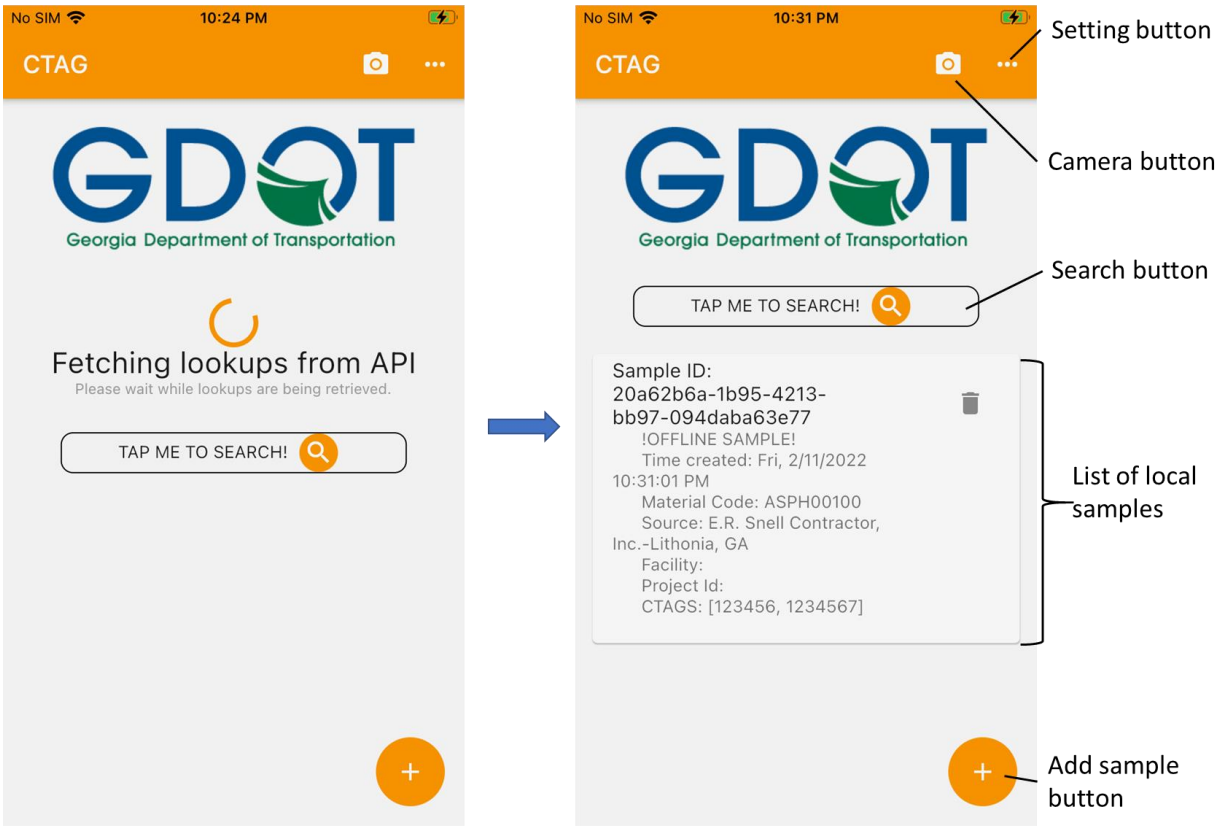

Figure 4. An example of the Sample listing screen.

SAMPLE CREATION SCREEN

The user can access the Sample Creation screen by clicking the “Add sample button” or activating the camera to scan a new barcode. The workflow of the Sample Creation Screen is shown in Figure 5. On the page, the screen lists several entries that can be filled. The user can fill those entries by selecting options from the lookup lists. Those lookup lists were downloaded from the API. This gives a range of possible options without typing. The user can add batch-specific information by touching the “Add batch” button. The new section will appear at the bottom of the scrolling screen. In the batch section, the user can add multiple CTAG numbers with a minimum number of two and a maximum of four by clicking the “Add CTAG” button. The user can also activate the camera as the barcode scanner to scan the barcode and load it to the field. Once all the entries are filled, the user can click the “Save” button to save the sample locally on the mobile device or the user can send the sample directly to API. This will upload the sample information to the AASHTOWare system and will remove it from the device.

The data elements for creating a new sample are listed in Table 2.

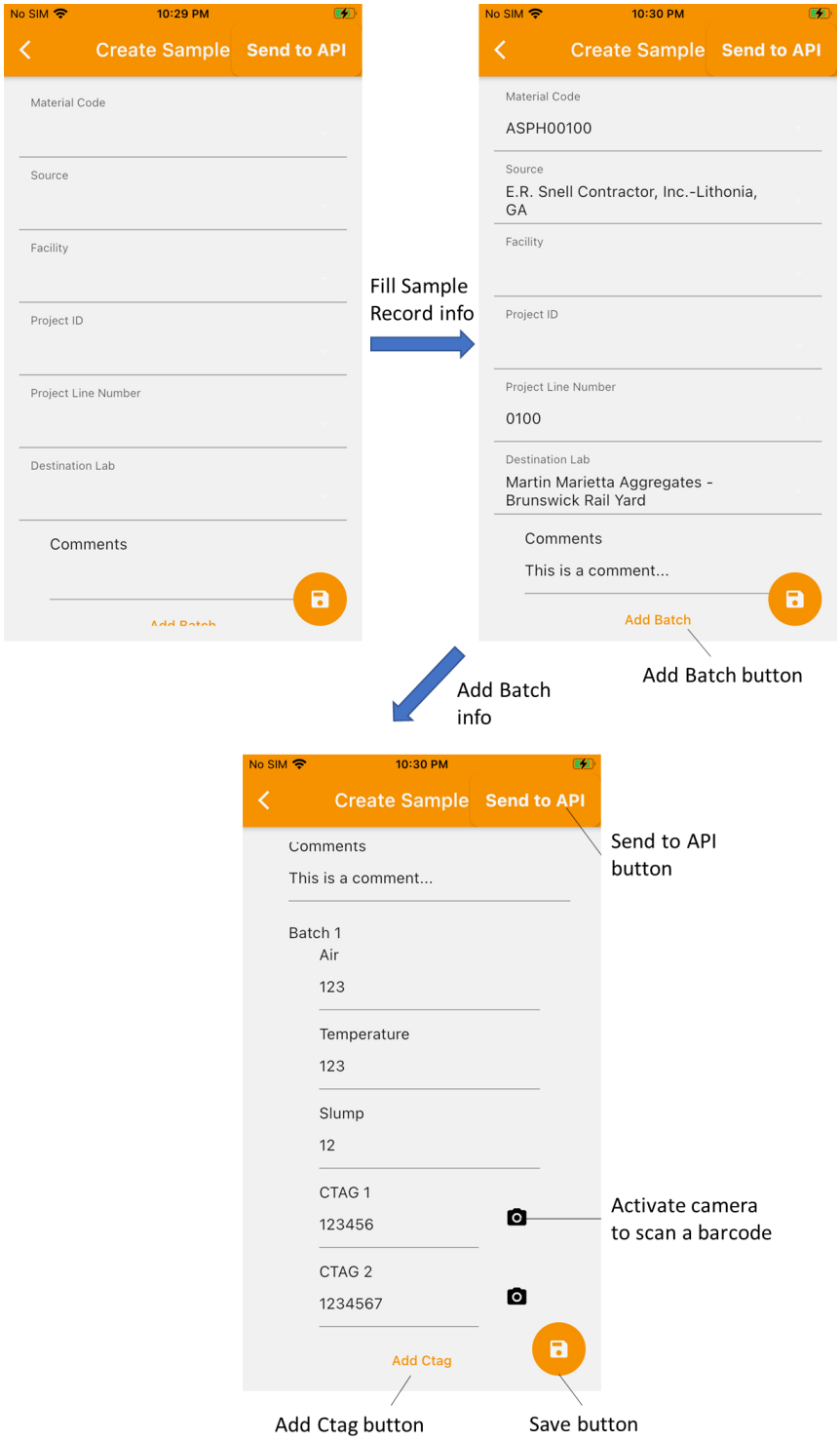

Figure 5. The workflow of the Sample Creation screen. The user needs first fill out the required fields of the Sample Record section and add the batch section by clicking the "Add batch" button.

Table 2 – A summary of the field names to be used and a summary of whether the material is required and the comments.

Sample Record:

Field Names	Is Required	Comments
Sample ID	NA	Sample ID will be generated on AWP Server after the sample has been uploaded
Material Code	Yes	Lookup
Source	Yes	Lookup
Facility	Yes	Lookup
Project ID	Yes	Lookup
Project Line Number	Yes	Lookup
Batches	Yes	Array of Batch Object
Comments	No	Open text box
Destination Lab	Yes	Lookup
User ID	Yes	Mobile user id
Created Date	Yes	Device date and time

Batch:

Field Names	Is Required	Comments
Batch ID	Yes	index starting from 1
Air	Yes	
Temperature	Yes	
Slump	Yes	
CTAG	Yes	1. Array of String 2. CTAG numbers 3. A Batch can have a minimum of 2 CTAG numbers and a maximum of 4 CTAG numbers

LIST OF LOCAL SAMPLES

An example of the list of local samples on the Sample Listing screen is shown in Figure 6, which shows the least number of data points per sample to identify a sample. Selecting a sample on the list would navigate the user to the Sample detail screen where a more elaborate view of a sample is presented. The list of data points that need to be displayed is shown in Table 4.

Table 3 – The list of data points needs to be displayed.

Field Names
Sample ID
Material Code
Source
Facility
Project ID
CTAGs

Figure 6. An example of a list of local samples.

SEARCH SCREEN

Clicking the Search button would navigate the user to the Search screen. The workflow of the Search screen is described in Figure 7. The user can type using the keypad or activate the camera to scan the CTAG number for searching. The app will send the search request to API and pull the research results from the API query and list them on the screen. The search result will list the Sample ID that contains the CTAG number that matches. Currently, the search feature does not search locally and only looks in the AASHTOWare online database. This means that once a sample is saved locally and shared with the AASHTOWare database then it

can be searched. The user can click the expand arrow button to see additional information. The user can view more sample details by clicking the view sample details button. This will take the user to the Sample Detail screen.

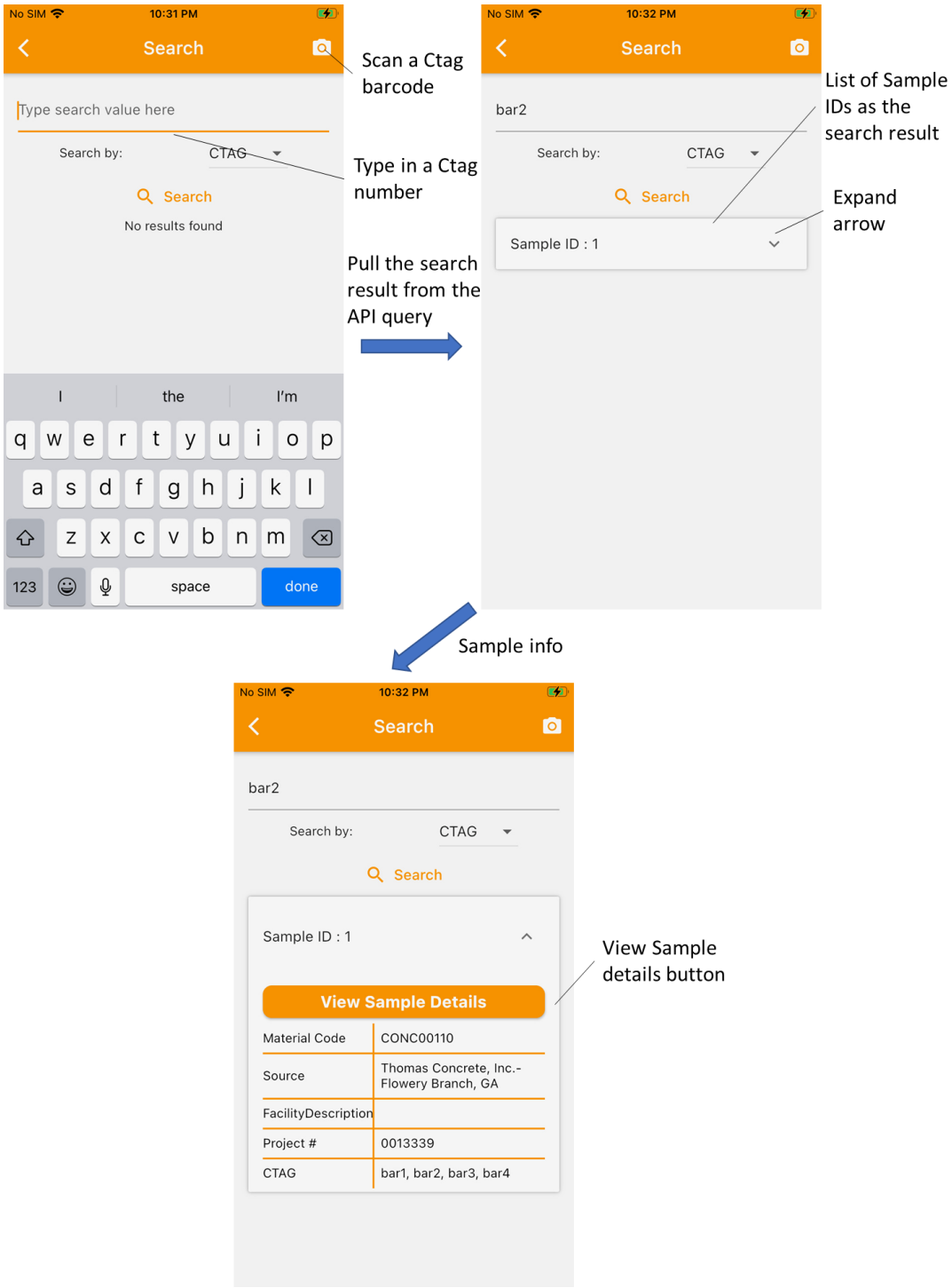

Figure 7. The search function will pull the search results from the API query.

SAMPLE DETAIL SCREEN

The user can see even more details on the Sample Detail screen. An example of the Sample Detail Screen is shown in Figure 8. One can download the sample to local storage by clicking the receive sample button. This is used when the samples are transferred to the lab for storage and testing.

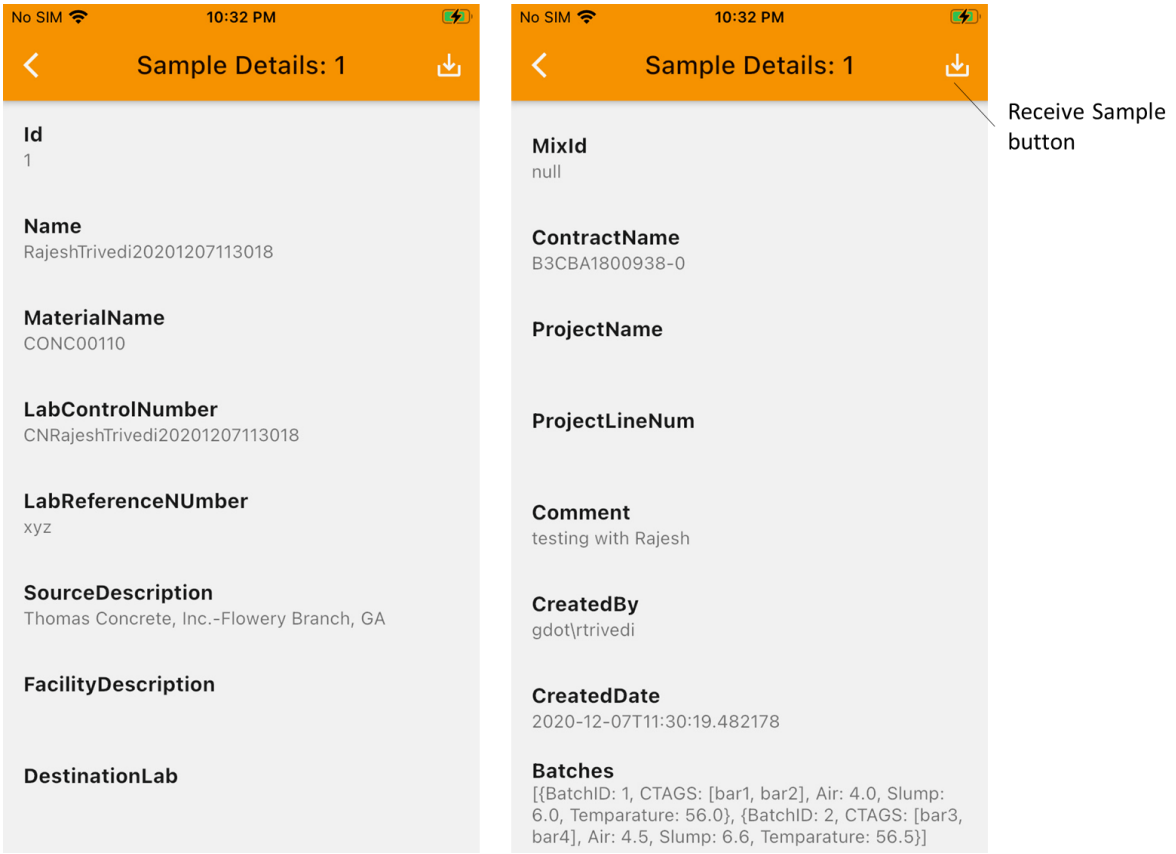

Figure 8. An example of the Sample Details screen.

RECEIVE SAMPLE SCREEN

When a sample is delivered to the lab, it can be checked in by scanning the CTAG and then clicking the Receive Sample button as shown in Figure 8. Only the Tester and Admin can access this button. A dialog screen will appear when this button is pushed as shown in Figure 9. The user can type in the lab information and select the checkbox for the CTAG numbers received. Once they click the "Yes" button to confirm. The Sample ID and the associated

CTAG number will be downloaded to the mobile device.

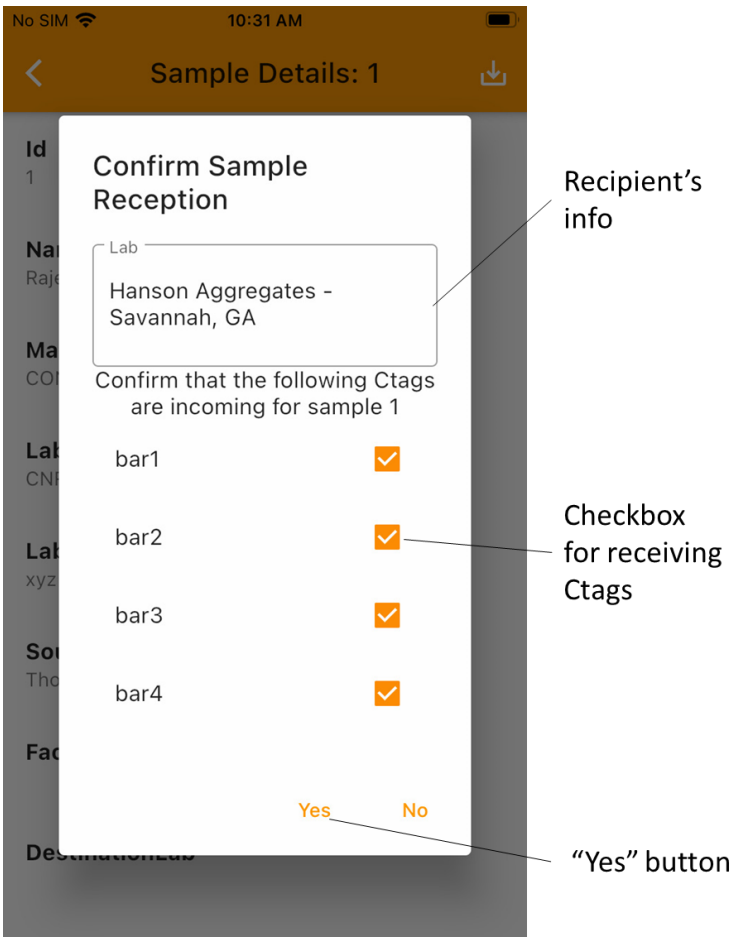

Figure 9. The sample receive screen allows a Tester and Admin to confirm that they have received the sample.

SETTING SCREEN

The Settings screen allows the user to manage user settings and preferences. An example of the setting screen is shown in Figure 10. The functions of the buttons are listed below

- Logout: Logout and navigate the user to the log in screen.
- Lookup Update: check the updates of lookup lists from API.
- Auto Sync: A Boolean switch when ON automatically uploads collected sample records

from a mobile device to AWP in the background. This default value is set to OFF.

The user information such as username and role(s) are shown in the user info.

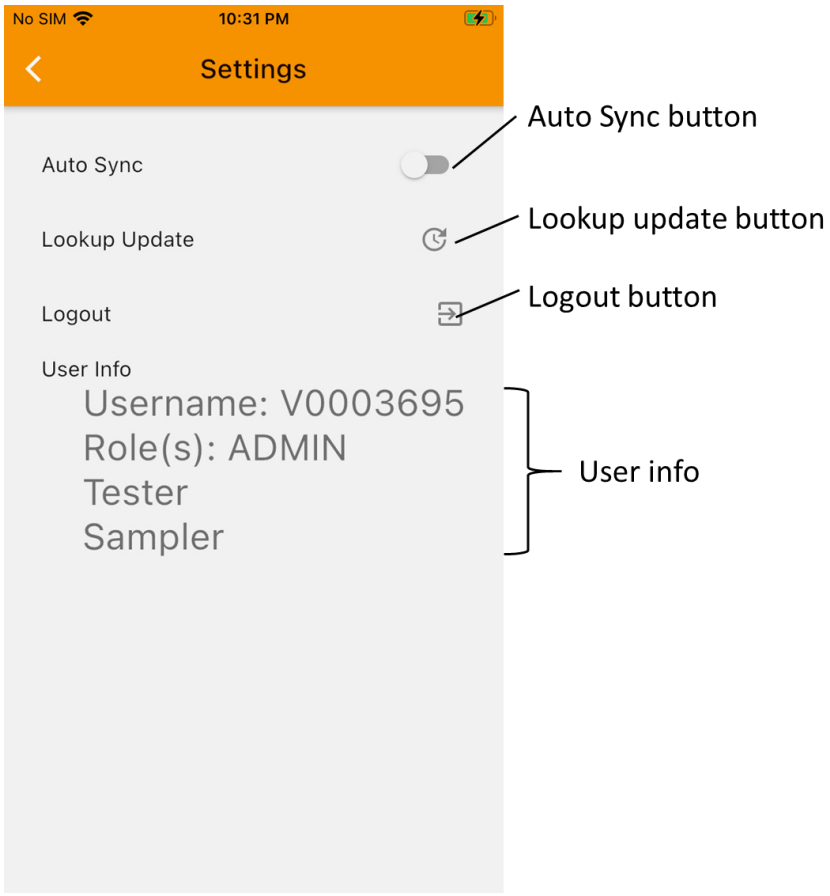

Figure 10. The settings screen, where the user can log out and change the user settings and preferences.

ASSUMPTION

Once a Sample has been uploaded to AASHTOWare Project, the User has to log in to AASHTOWare to make changes to the sample record.

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