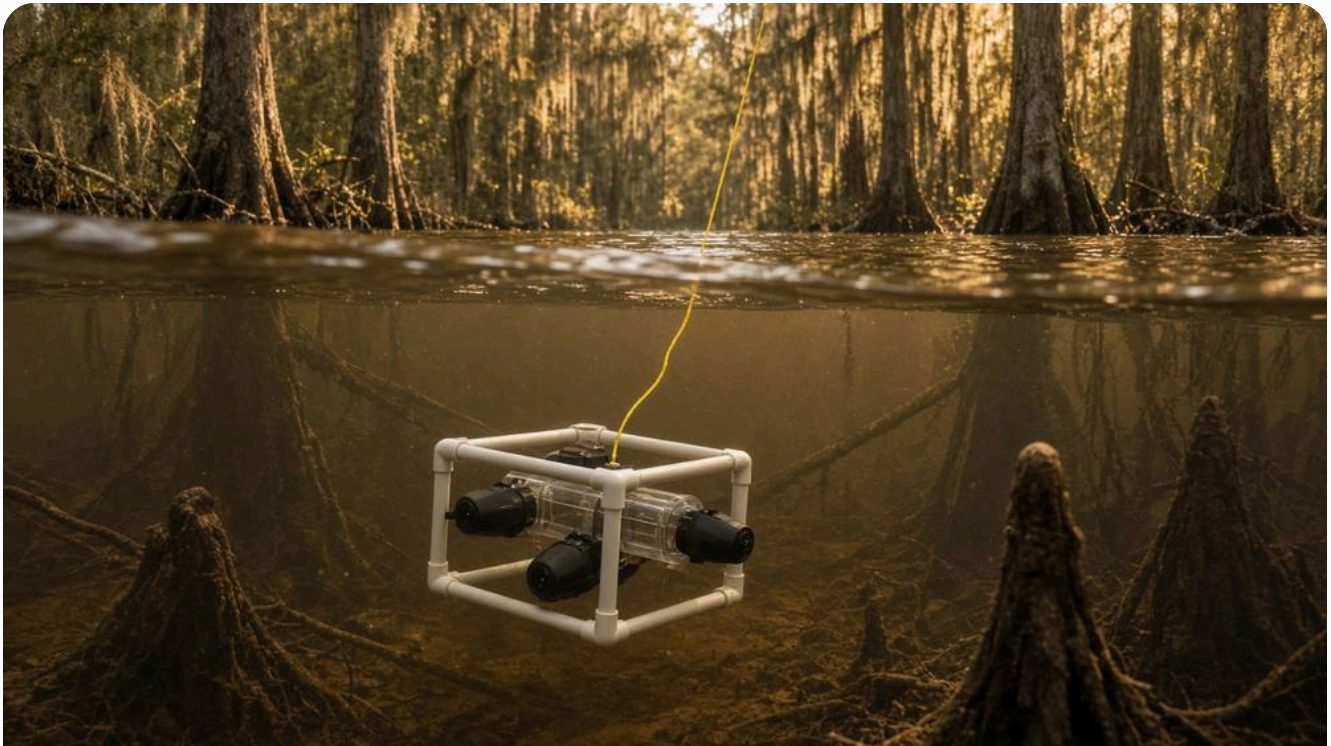


Grok Mini Sub: Staged Build

A tethered mini ROV that takes Grok under the water at Caddo Lake, run from Max's own Raspberry Pi 4 and 10-inch touchscreen. Stage 1 about \$275, Stage 2 about \$435 more (running total about \$710), optional extras from about \$40 each.



COPPER GATOR MARINE

Grok Mini Sub

The drone sees the lake from above. The sub sees what's under it. Max stays dry on the dock and talks it through with Grok.

Concept render: a Stage 2 mini ROV under the tea-colored water of a cypress lake

What it is

The mini sub is the swarm's underwater member. It's a small tethered ROV: a camera, thrusters and later sensors on a light PVC frame, wired to a surface station on the dock or truck. Radio and Wi-Fi die within inches underwater, so a thin cable carries the

power and video. Max asks "What's under the dock?" and Grok watches the feed and answers out loud.

Uses what he owns

His Pi 4B and 10-inch touchscreen are the surface station. Grok's voice, the video and the controls all live there.

Nothing to flood in Stage 1

All the electronics stay topside. Only a sealed camera and sealed thrusters go in the water.

Light work

About 5 to 6 lb in air. Seated bench work, solder joints and zip ties. No heavy lifting, no wading.

Grows with him

Every Stage 1 part stays on the Stage 2 build. Extras bolt on later.

The stages

STAGE 1: LOOK AND TALK

~\$275

Tethered camera ROV. Video to the Pi 4. Grok sees and talks. Pool, dock and shallow lake, about 10 ft.

STAGE 2: HOLD DEPTH, SEE IN THE DARK

+~\$435

Sealed sensor pod, depth sensor, compass, lights, depth hold. Rated to 10 m. Running total about \$710.

STAGE 3: EXTRAS, PICK ANY

from ~\$40

Sonar, a gripper, water-quality probes, a tether reel, a truck or trailer launch kit.

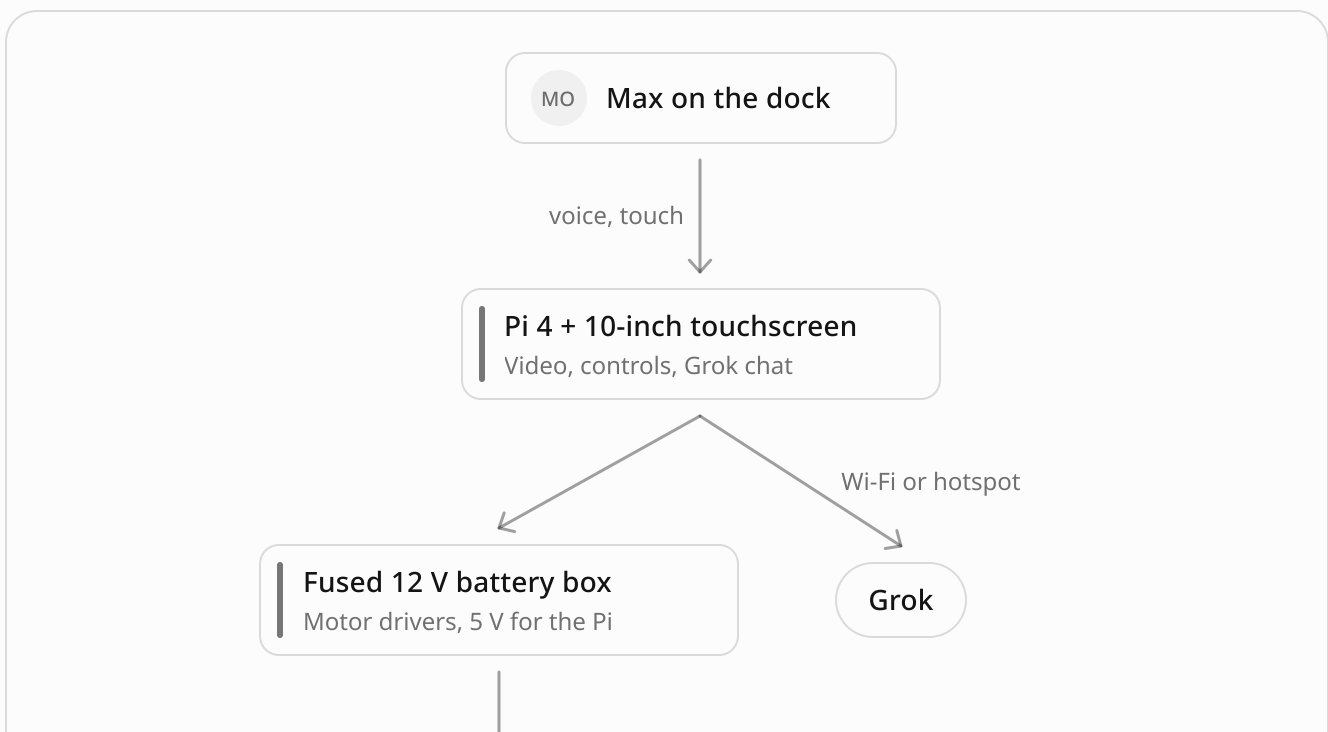
Prices marked ~ are estimates. Verified vendor prices are flagged in Under the Hood.

The surface station: his Pi 4 and 10-inch screen



Concept render: Pi 4, 10-inch touchscreen, fused 12 V battery box, controller and tether reel on the dock

The Pi 4 stays dry on the dock. It reads the sub's camera over USB, drives the thrusters through motor drivers in the battery box, and runs the Grok voice and vision chat. The touchscreen shows the live feed with tap controls. The mountable display goes in the truck or on the 16-ft trailer later, as a 12 V station.



↓

15 m tether

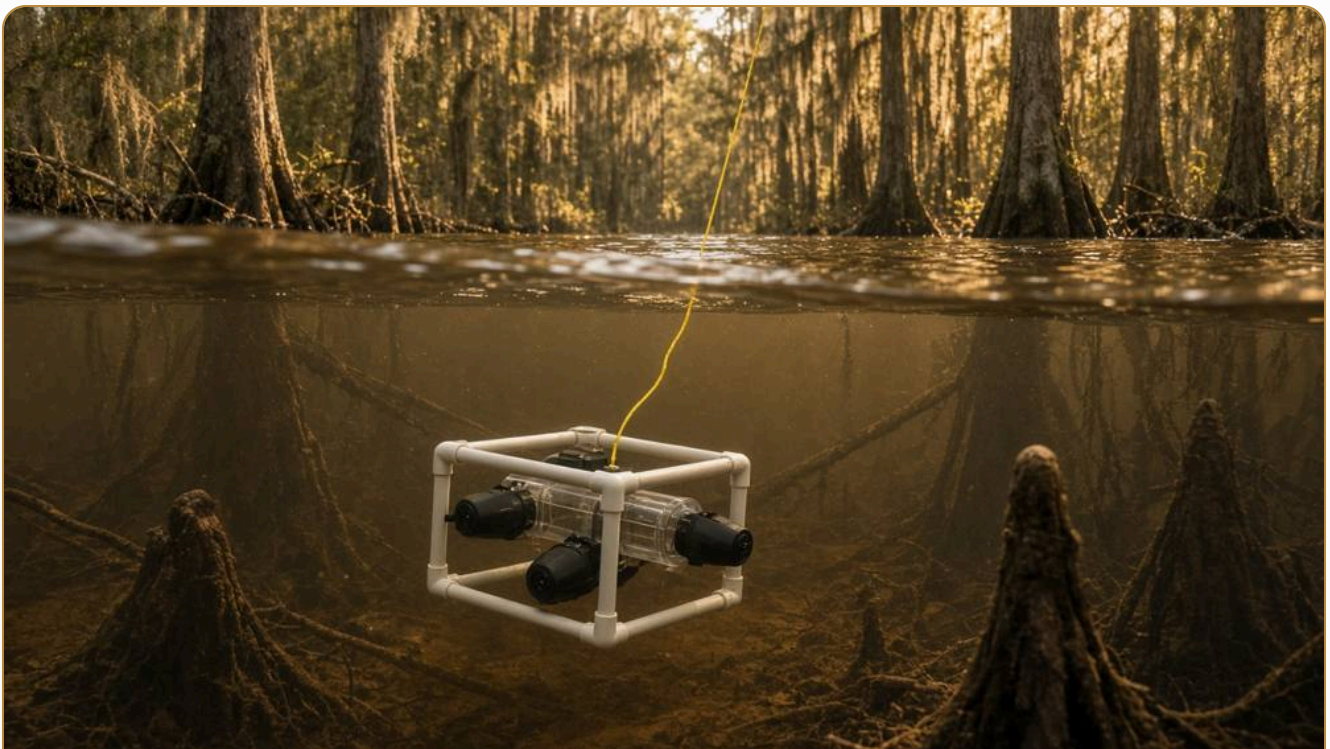
Motor power + camera USB + pull ...

↓

Mini sub

Camera, 3 thrusters, floats

Stage 1: the cheapest sub that sees and talks



Concept render: the PVC-frame ROV with its tether rising to the dock

- Three sealed 12 V brushed thrusters (\$30.78 each, Amazon): two push it forward and turn it, one pushes it down.
- A USB endoscope camera on a 15 m waterproof cable, with its own LEDs. The Pi sees it as a webcam.
- Motor drivers sit in the dry battery box on the dock. No electronics go underwater, so there is nothing to leak.
- Trimmed slightly floaty with pool noodle. If power drops, it floats up on its own.

- Honest limits: about 10 ft in practice, murky Caddo water limits the view to a few feet, and the camera is low resolution.

Stage 2: hold depth and see in the dark



Concept render: Stage 2 with a 3-inch sealed pod, four thrusters and two dive lights



Vendor photo, Blue Robotics: Bar depth sensor. The Bar02 (\$80) reads to 10 m at 0.16 mm resolution

- A Blue Robotics 3-inch watertight tube with an aluminum end cap and WetLink cable glands, rated far deeper than the sub needs.
- Inside: an ESP32-S3, a BNO085 compass and tilt sensor, and a Bar02 depth sensor, talking to the Pi over RS-485 on a spare tether pair.
- Depth hold: the Pi runs a simple PID loop on the vertical thrusters. Tap a depth on the screen and it stays there.
- Two self-contained dive lights ride on the front. No extra wiring.
- A vacuum test before every dive proves the pod is sealed before it gets wet.

Stage 3: pick your extras

Extra	Budget way	Pro way	What it adds

Sonar	~\$100 castable fish-finder sonar	\$430 Blue Robotics Ping2	Sees the bottom and snags in murky water
Gripper	~\$40 waterproof servo + printed jaws	\$720 Newton gripper	Grabs lost tools, frees a snag
Water quality	~\$60 pH, TDS and temperature probes	Pro probes start near \$2,000	Logs water readings for Grok
Tether reel	~\$45 hand reel + braided pull line		Neat paying out, easy pull-back
Truck or trailer launch	~\$55 kayak cart + 12 V buck		Mountable display becomes a mobile station

How it fits the swarm

Scout drone finds the spot

It flies over the lot or the lake edge and marks where to look. The sub goes under.

Companion drone watches the tether

From above, it spots snags, logs and gators near the line.

Robot body is the ground crew

It can hold the station, announce status and carry the light Stage 1 sub.

One Grok, one voice

The same Pi voice chat runs every member. The sub's clips go in the same mission log.

Launching the sub from a drone isn't practical. A 5 lb sub plus wet tether is far past what the 7-inch or S500 can lift safely. It launches from the dock, the bank, a boat or the trailer.

Safety first, dry feet always

- Max never goes in the water. A snag means cut the tether's pull line or wait. Never wade after it.

- Gators live on Caddo Lake. Stay back from the edge, no dusk or night runs, and pull the sub in with a boat hook, not a hand.
- Only 12 V DC ever goes down the tether. Fuse the battery. Any 120 V charger or inverter near the water goes on a GFCI.
- The heaviest piece is about 6 lb. Build sitting down, take breaks in the heat, and bring a buddy to the lake.
- Giant salvinia and hydrilla are in Caddo. Clean, drain and dry the sub before leaving. Louisiana bans moving giant salvinia.
- From a boat: Louisiana boating rules apply, including life jackets. Part of Caddo is Texas water, with Texas rules.

✓ Under the Hood: parts, costs and engineering

Stage 1 parts

Part	Price	Notes
3x cheeyoo 12 V DC brushed underwater thruster	\$92.34	Verified, Amazon B0D5JN1Z5R at \$30.78 each
USB endoscope camera, 15 m waterproof cable, LEDs	~\$30	Estimate. Shows up as /dev/video0
3x BTS7960 H-bridge motor driver	~\$27	Estimate. Topside in the battery box
50 ft 18 AWG 8-conductor cable	~\$35	Estimate. 3 motor pairs + 1 spare pair
Braided pull line, 1/8 in	~\$8	Estimate. Carries the pull, not the wires
12 V 6 Ah LiFePO4 battery + 10 A fuse	~\$36	Estimate
12 V to 5 V 5 A buck for the Pi	~\$10	Estimate
PVC pipe, fittings, pool noodle, dive weights	~\$25	Estimate
Marine heat shrink, liquid tape, silicone	~\$12	Estimate
Stage 1 total	~\$275	Uses his Pi 4B and touchscreen

Stage 2 parts

Part	Price	Notes
Blue Robotics 3-inch watertight enclosure, aluminum cap	~\$110	Base enclosure verified from \$61; configured price estimated
5x WetLink penetrators	~\$75	Verified \$13 to \$17 each
Bar02 depth sensor	\$80	Verified range \$80 to \$90 for Bar02/Bar30
ESP32-S3 board	~\$15	Estimate
BNO085 IMU	~\$25	Estimate
2x RS-485 transceivers	~\$8	Estimate. Uses the spare tether pair
4th thruster (second vertical)	\$30.78	Verified, Amazon
2x self-contained dive lights	~\$40	Estimate
Vacuum plug + hand pump	~\$45	Estimate
DIY leak probe	~\$5	Estimate
Stage 2 total	~\$435	Running total about \$710

Running totals

Step	Adds	Running total
Stage 1	~\$275	~\$275
Stage 2	~\$435	~\$710
Stage 3 common picks: budget sonar, gripper, water probes, reel	~\$245	~\$955
Pro path later: Navigator + second Pi 4 + Fathom-X pair for BlueOS/ArduSub	~\$555	~\$1,510

Vendor parts for the pro path



Vendor photo, Blue Robotics: T200 thruster, \$230 each plus a \$27.60 US tariff surcharge. 3.7 kgf at 12 V, tested to 300 m

Fathom-X tether board

\$140 single or \$280 pair. 80 Mbps Ethernet over one wire pair, 300 m and up. Needed only for very long tethers.

The pro path moves to BlueOS and ArduSub: a Navigator board (\$220 and up) on a second Pi 4 inside a bigger pod, with Fathom-X on each end of the tether. It's worth it only past about 100 m of tether or for HD video. Under 100 m, plain Cat5 Ethernet works without Fathom-X.

Engineering notes

Topic	Stage 1	Stage 2
Waterproofing	Sealed off-the-shelf camera and thrusters. Splices in marine heat shrink, filled with silicone	O-ring tube, WetLink glands, vacuum test to about -0.3 bar for 15 minutes
Buoyancy and trim	Pool noodle on top, dive weights low. Aim slightly positive	Same rule, re-trim with the pod. Floats up if power fails
Power	12 V LiFePO4 topside. About 3 A per thruster, so 18 AWG over 15 m drops about 2 V	Same pack. The pod runs on 5 V from a buck
Control	Pi GPIO PWM to BTS7960 drivers. Touchscreen or USB	Pi PID depth and heading hold from ESP32 data over

	gamepad	RS-485
Video	USB endoscope, 640x480 to 720p. USB over 15 m works because the cable is built in	Same, plus lights. Pi camera in the pod is an option
Depth rating	About 10 ft in practice, limited by the camera and thruster seals	10 m, limited by the Bar02; the enclosure is rated far deeper

Grok integration

1

Plug in

Camera to USB, battery box to the Pi's GPIO, speakerphone to USB.

2

Grab frames

OpenCV reads /dev/video0. Every few seconds one frame goes to Grok vision.

3

Talk

Grok voice runs on the Pi's mic and speaker. Max asks, Grok describes what it sees.

4

Mission-level only

Grok can call record, light and hold-depth tools. Max keeps the sticks.