

WIRELESS MONITORING SYSTEMS IN SEPTIC AND GRINDER MAINTENANCE OPERATIONS

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ABSTRACT

A considerable number of wireless products have been (and will continue to be) entering the market for the monitoring of septic and grinder pump systems. This report's purpose is to create a useful archive of information that will assist septic operators with both the business and technical aspects of using wireless technologies.

The objectives of this guide are providing the material to accomplish a wireless offering, namely:

- Assist septic operators to become competent in the technologies with the aim of determining when it makes sense to deploy wireless technology, what type of technology to use, define the approach when it makes sense, and define when bow out gracefully.
- Understand how to adapt the business plan to systematically make money, reduce emergency calls, and balance the business of deployments of new technologies without it turning into a nuisance.

The paper endeavors to answer 4 key questions we estimate most septic installers have about wireless monitoring:

1. Why bother with it?
2. Can we make money with it?
3. How do we adopt it without distracting from our key business?
4. What specific technical information do we need to know? What are the limits?

The research that is offered in this paper is from the experience of developing and deploying wireless products and helping innumerable numbers of customers and installers with wireless installations.

INTRODUCTION

As a septic operator there are operational advantages to wireless monitoring technology. Wireless technology can be a differentiating factor and a path to controlled septic/grinder maintenance. Conversely, it can be intimidating because the skill set appears as requiring a septic, electrical, and an IT expert to pull it off. In countless discussions with septic installers over the years, most calls generally start with, "I have a customer who wants this" and the overall tone is reluctance.

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Homeowners don't want to pay for excessive pumping nor experience a septic back-up. Wireless technology provides a balance that serves both parties. The tank should be pumped when it is nearly full or has a problem but before it becomes a nastier job than it must be. Being called only when a septic or grinder system stops operating brings risk to the homeowner and makes service calls longer and planning more difficult for the septic operator. The value of these systems is to move the customer and septic operator to Autonomous Condition Based Maintenance. The prerequisite is that both septic operator and customer must share a common interest in keeping the system running smoothly, avoiding the expense and the burden of "emergency calls", and providing for the fact that they would like the knowledge of the situation without someone directly monitoring a local alarm.

In fact, for all equipment in industry, there are 9 known maintenance strategies (See Appendix I - The Nine Tiers of Maintenance Strategies, Page 11). Effectively, the higher the tier, the smoother the customers system and the septic installers business operate. To progress up the tier takes planning and some cases investment. In any industry, the maintenance levels are the same. The technology is not widely nor cost effectively available today to move to level 9 (Prescriptive Maintenance). Use of wireless monitoring technology can move the number to 7 (Condition Based Maintenance), where both customers and septic operators mutually benefit. The principle of Condition Based Maintenance can be expanded further using wireless monitoring to "Autonomous Condition Based Maintenance" where human interaction is further minimized.

In feedback from end-users (homeowners who are deploying wireless technology), one of the key questions that they want to know is, "Can I install it myself?" as well as, "Do you have a local installer?". The installation is a key motivator a homeowner would call a septic company to have an alarm installed. A given septic operator does not necessarily need to offer multitudes of products. Perhaps one or two products will serve for a given customer base.

From a financial standpoint, installers can make a profit on every aspect of the deployment. The physical hardware can be purchased at a discount, the installation is a billable service, and in the case of turnkey solutions for some key customers, there is potential for residual revenue. Based on a P&L review of product line services from several septic operations, it's doubtful that becoming an installer of wireless technology will make a dramatic difference in the bottom line of a septic operation. The value is to identify the customers that are a fit and to move them into the autonomous conditional maintenance realm without taking focus off the core business.

MATERIALS AND METHODS

The following steps are the process to coming up with a minimal yet viable offering for a septic operator:

- A. Create an Offering
- B. Connectivity Options: Wi-Fi or Cellular?
- C. Assess and Quote the Physical Installation
- D. Achieving and Maintaining Connectivity

A. Create an Offering

To begin offering a service the management and drivers are most effective when there are a predesigned set of programs. Reference Table 1 as a guideline for an offering.

Table 1: Potential Plan Structures			
Plan	Plan Description	Hardware Owner	Wi-Fi or Cellular
Plan 1: Hardware Only	Customer wants a wireless system. They purchase through the septic installer, and it is drop shipped to them.	Customer	Either
Plan 2: Hardware & Installation ²	Customer purchases the hardware and pays for the physical installation. This completes the scope, and the customer is responsible for connecting it to wireless service and calls the manufacturer if they have additional questions.	Customer	Wi-Fi
Plan 3: Hardware, Installation & Set-Up ³	Plan 2 + connection the unit to the customers Wi-Fi Network or cellular network for a fee. Customer provides network name and password.	Customer	Avoid
Plan 4: Complete Turnkey ⁴	Installer does everything including alarm maintenance. Perhaps customer does not even receive notifications.	Installer	Cellular

² Note that the option of installing equipment a customer purchases is not present. This can be done, but there can be surprises with unknown equipment. For this reason, it is suggested to work with known equipment.

³ Overall, given the options, general counsel is avoiding Plan 3 (Hardware, Installation, and Set-Up). If the customer owns the hardware, the customer must know how to operate and maintain it.

⁴ Plan 4 Turnkey is more structured for cellular because as an operator there is no control over a customer's Wi-Fi network.

The various offerings can be structured as billable items in the accounting system. The billing text for each item can be constructed to contain:

- Installation scope (i.e., Installation scope includes mounting the alarm and installing and connecting the float switch in the tank and connecting it to the device)
- Power to the device provided by customer (i.e., Customer is responsible for providing an open and operational power outlet.)
- The limit on the distance between the alarm and the tank (i.e., Cabling between alarm and tank will be provided in existing conduit with a maximum distance of 30 feet.)
- Responsibility for device registration and to maintain the equipment and network connection (i.e., Customer responsible for connecting and maintaining and device with local wireless network, device on-line registration, and structuring of notifications.)
- Ongoing, annual fees (i.e., Ongoing cellular service will be provided at a rate of \$100/year.)

- Equipment Warranty (i.e., The warranty of the equipment is directly between customer and the manufacturer of the device.)
- Batteries and battery replacements (i.e., Battery will be changed annually as part of our service, or Customer is responsible for changing of any internal batteries.)
- An administrative email address for your company to be copied on the notifications (i.e., admin@yourseptic.com)

Installation is dependent on the plan and may or may not be included. If installation is included, in all cases except Plan 4 (Turnkey), the installation scope should be limited to install the head unit ² (typically into the home foundation or other structure where the other controls are located), set the float switch, run the cable, and hand the manual to the owner with the instructions for what they need to complete.

CASE STUDY: A plumbing company purchased several cases of sump pump alarms with the idea of creating an upsell to customers. The customers purchased the alarms with the expectation that the plumbing company would do the complete set-up and the homeowners would simply receive alerts when there was a problem with their sump pumps. When the plumbers left the installation site, the customers had no information on how the system operated, how to login to the website, or make a change if the wireless password changed or to add notifications to a family member. The result was that customers received a bill where they paid full rates for a plumber to connect the device to their network and create a website registration. The situation was remedied when the scope was more clearly communicated. The plumber's scope was limited to physically installing the device, giving the customers the number for the manufacturers technical support, and handing them the manual to do the set-up.

B. Connectivity Options: Wi-Fi or Cellular?

The two pre-eminent wireless offerings at the time of this writing for septic and grinder application are Wi-Fi and Cellular. Both have advantages and disadvantages, which can be seen in Table 2.

The most advisable approach is to have a single product offering in Wi-Fi, and a single offering in cellular. Set up the plans accordingly and deploy each based on the best solution for the application.

² A general term used to refer to the box or enclosure holding the electronics. Typically, the head unit requires power, has a connected float switch, and houses the wireless hardware.

Table 2: Wi-Fi vs. Cellular		
	Wi-Fi	Cellular
Hardware Purchase Cost	No significant difference	
Annual Cost of Service to Provider	Little or None	Annual Plan (typically about \$50/ year)
Site Requirements	Customer has an existing Wi-Fi network available	Cellular Network is available
Customer Technical Aptitude	Customer has other Wi-Fi devices in their home and manages their network.	None. Set and forget.
Power Outage	Generally, when power or internet are absent, the remote monitoring will stop. Some units function as local alarms provided the alarm has back-up power. Unit can notify that “power or internet” have been lost.	Remote monitoring continues provided the equipment has back-up power. System can notify users that specifically that power is lost.

C. Assess and Quote the Physical Installation

Using Plan 3 as an example, a standard hardware and installation package can be created with scope limits which create a billing item that can be efficiently administered in terms of quoting and obtaining an order for the installation. The next administrative step is getting the information to validate the product an installation scope match to the customers’ requirements and expectations. This too can be executed administratively. The goal of this discussion is that the customer and the installer are made clear on costs, scope limits, and potential risk areas.

In a discussion with a potential customer, the following information should be asked or taken.

{For administrative efficiency, a complete questionnaire and script is included in Appendix II – Sample Site Survey Questionnaire / Script (Page 12).

- ✓ Is Wi-Fi or Cellular Service Desired?
- ✓ Where will the alarm be mounted?
- ✓ What is the distance between the alarm and the septic/grinder tank/station?
- ✓ What penetrations are necessary (i.e., new entry into a concrete septic tank, basement foundation, plastic septic holding tank)?

Installation Notes

The alarm unit will require power. The float switch will need to be connected from the tank to the head unit. While it's possible to have a new independent location, most installations are located either on the outside wall of the home nearest to the septic/grinder system or in the location of the grinder/septic existing controls.

It should be considered in each quote to put the float switch from the wireless system in a separate pipe because it is carrying a low voltage DC (Direct Current) signal. Standard grey PVC electrical conduit is the standard for this, and the National Electrical Code (NEC) allows for low voltage electrical conduit to be buried at a depth of 6 inches³. This differs from 120V AC signals which require a 12-inch depth. Thus, determining the right location for mounting the alarms head unit is the first step to determining the overall distance. The cord length of the float switch needs to be considered and a single float switch can be selected that is already in inventory that will work with the two models of alarm that are chosen.

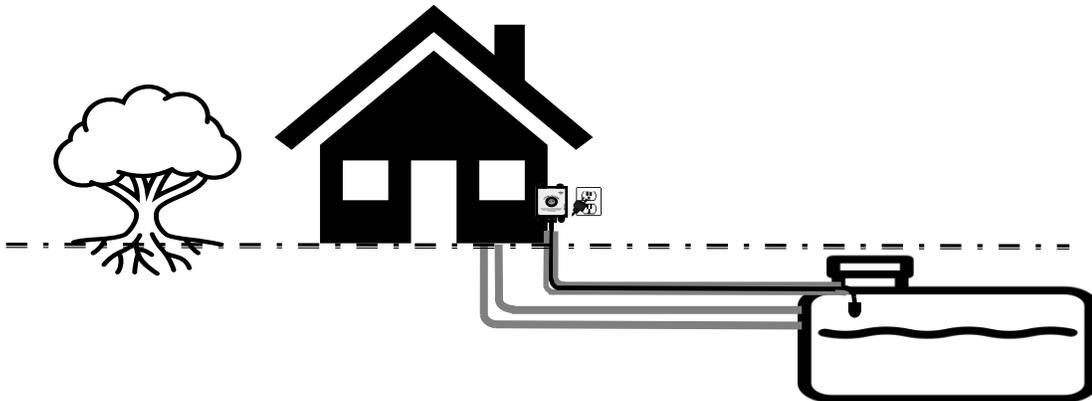


Figure 1 - Typical Installation

If the conduit / wire path is longer than the float switch lead length, this will add extra field work to extend the float switch cable. Splicing and or connections that are made in the field need to be waterproof. In turn there may be additional labor and /or materials needed for the project.

A typical installation of this nature on a standard home should take about 60 to 90 minutes.

Installations are best structured in advance and consolidated into one visit with other business.

Reference “Appendix IV – Suggested Installation Equipment List, Page 17)” for a basic list of equipment that is typically required for an installation.

³ National Electrical Code (NFPA) Table 300.5

Installation Pitfalls

In the process of streamlining an offering, it is important to understand why installations consume more time than quoted. Having to leave the site and return can be the end of the profitability for an installation. Common reasons for this include, poor scope definition, not having the correct tools, float switches with cable lengths shorter than the conduit, and difficulty passing the cable through the existing piping.

It's common to hear the question from homeowners, "I already have a float switch in the tank for high level, can I use the same float?" The short answer is most often 'no'. Many of the wireless systems on the market are putting a DC (Direct Current) signal onto the float switch, while non wireless systems typically use 120VAC. If AC power is applied to a DC device, it could cause damage to the wireless alarm, which could lead to the need for a replacement. It is best to separate the AC and DC wires from the start to reduce confusion. This approach also avoids having a technician with a high hourly rate trying to sort out a host of unidentified and unlabeled wires in a customer's panel to "save money".

The wireless electronics should never be mounted in the tank. Wi-Fi and cellular signals travel freely in empty space and a portion of the signals reflect off items that are in their path. While waves can travel through drywall and siding, they have great difficulty penetrating earth and cement (Placeholder2). Even in a completely waterproof enclosure, the probability of a reliable operation is low if the unit is mounted internal to the tank.

A key point in any wireless installation is being sure the device indoor/ outdoor ratings match the environment. An indoor device can be mounted outdoors but only in a plastic weather resistant (NEMA 4X, IP67/68) enclosure. Metal enclosures will not work for housing wireless equipment as metal has reflective properties that do not work with wireless. Alternatively, if the site provides for it, the alarm can be indoors if the float switch cable can be passed through the wall. If your selected manufacturer does not offer outdoor rated equipment, they can still be used, but the equipment will need to be mounted and this needs to be factored into the plan that is offered.

D. Achieving and Maintaining Connectivity

One of the questions this paper endeavors to answer is how to adopt wireless technology without it becoming a distraction from the core business. As mentioned in the case of the sump pump installers, this is the pivotal point in minimizing the distraction. General connectivity guidelines are as follows:

- Whoever the device owner is as outlined in Table 3, maintains the wireless connectivity.
- When the customer owns the connectivity, it should be made abundantly clear to the customer that they will be responsible for it. In Wi-Fi world, this can be more of a task than cellular world. In cellular world, it mostly means that they pay the bill.

- In the case of schools, hospitals, etc., it's not advisable to be the owner the connectivity where Wi-Fi is concerned. These places have firewalls and other dynamics in their wireless networks that can create time sinks and require more of an IT level of knowledge. Let the owner and device manufacturer work together to accomplish the connectivity.
- Keep in mind that some of the devices (dependent on manufacturer) may have lead acid batteries that need to be replaced periodically. this responsibility only becomes significant during a power outage. It's generally undesirable to have to send someone 50 miles to change a battery. If this is a site that is near or frequently visited, changing a 9V battery periodically may be acceptable.

Manufacturers build and ship devices and do not know which customer is receiving which device. Once the customer has a "connected" device the process is still not complete. While the device may have a connection to the internet, it still needs for that device to be connected to the owner. Each device needs to be associated with a customer, and the notifications (i.e., text messages and emails) need to be structured, which requires an online registration.

Who should register the device? Referencing Table 3, the device OWNER should do the registration and structure the notifications, and it is prudent to request that they have include notifications to an administrative email address at your company that can be periodically checked (i.e., admin@yourseptic.com).

For cellular units, the cellular service will typically activate only after the registration is made. For Wi-Fi devices, the device may or may not be connected to the internet when the device is registered.

Cellular Network Connectivity Maintenance

There is a stark difference in maintaining connectivity between cellular and Wi-Fi technologies, with reliability generally tipping to the cellular side. Outside of making sure they have paid for their plan, and that the alarm has power, the connectivity is completely in the hands of the cellular provider and device provider.

Wi-Fi Network Connectivity Maintenance

Conversely, owners of Wi-Fi devices will need to contend with devices going offline. It's important to note that this is not a concern for a septic installer. It is the business of the device owner and device manufacturer technical support to deal with those type of issues.

Devices can fall offline from network confusion⁴ between the 2.4GHz and 5GHz networks. There are settings in the customers wireless router that can correct this. The short story for an installer is the devices on the market (not just for septic, but for every application) are largely

⁴ The devices are not really confused. Newer routers out of the box are often set-up to assume that all network devices are 5GHz compatible, and if they have high signal strength, they can be shifted to the faster 5GHz network. This does not work with IOT devices.

2.4GHz. Manufacturers design for 2.4GHz because they desire range more than speed. If there is one sentence to tell a Wi-Fi customer, it would be:

“Customers are going to have their best results putting these devices on a dedicated 2.4GHz Guest network.”.

Guest networks are made for security. Guest networks provide the “guest” with access to the internet, and that is all. They cannot print to local printers, view, modify, or request information from another device on the homeowner’s main network.

For more detailed analysis on power loss, reference Appendix V - Power Loss

DISCUSSION

The goal of the deployment of wireless technology is (where possible) to provide autonomous conditional based maintenance which avoid emergency calls for a septic operator, and service outages for the end customers. The goal can be achieved regardless of what party owns and operates the equipment.

From a financial standpoint, installers can make a profit on every aspect of the deployment. The physical hardware can be purchased at a discount, the installation is a billable service, and in the case of turnkey solutions for some key customers, there is potential for residual revenue. Based on a P&L review of product line services from several septic operations, it’s doubtful that becoming an installer of wireless technology will make a dramatic difference in the bottom line of a septic operation. The value is to move key customers into the autonomous conditional maintenance realm without taking the focus off the core business.

If done with the proper scope definition, the technology adoption can be made with little or no disruption to the business.

STEP 1: With the knowledge that any septic operator has of their customer base they can make a few key decisions on what technology or technologies best suit their customers, select 1-2 products and purchase or request samples and use them for home use to get acquainted with the technology.

STEP 2: Establishing 1-2 standard offerings (Table 3) in the accounting system. Limit the scope of the offering to what the business could regularly and efficiently execute within the existing skill set.

STEP 3: Establish an office form or word doc for a potential site survey (Appendix I). This information can be provided by the customer via emailed or texted photos without being on-site. The collection of this installation information can mitigate the risk of multiple service calls to execute an installation.

STEP 4: Call or create an email campaign to a limited number of customers to test demand. Incorporating the wireless products into regular annual inspections or pumping calls is the most efficient method of execution. This allows the installation to be put on order and scheduled for a time of the year or time of the month that works in the scheduling.

STEP 5: Start with a single company resource who is willing to execute installations and provide the required hardware and equipment and provide feedback on how the process can be improved. Record the time it takes to execute each installation and the causes of potential delays.

STEP 6: If the initial installations are successful, consider a larger email campaign, changing standard stationary, or putting an insert into all billings for invoices for emergency services. There is a balance between the premium for emergency service calls and the cost of the deployment.

The most important part of ensuring that having a wireless offering is being sure that the offering matches to what the business can administer and execute. For example, if a company has no way to automate an annual billing process, perhaps that is a limiting factor that eliminates the idea of turn-key service. If an operator has young techs that are Wi-Fi fanatics, that may change the dynamics of what is offered and how.

ACKNOWLEDGEMENTS

Simpson Engineering offered the specific code sections which apply to direct burial depth for low voltage conduit. We thank Dan Simpon for his time and insight.

Grant Czapla and Debbie Steiger, for their careful proofread and feedback.

LITERATURE CITED

National Electrical Code (NFPA70), 2008 Edition, Table 300.5, “Minimum Cover Requirements, 0 to 600 Volts, Nominal, Burial in Millimeters (Inches)”, Column 5.

U.S. Energy Information Administration Documents, available on www.EIA.gov has numerous excellent references on power outage reasons and times, including breakdowns by states.

APPENDICES

Appendix I - The Nine Tiers of Maintenance Strategies

TIER	Maintenance Strategy	Example
1	Reactive maintenance	The septic system has a condition that stops the system from working. The customer has no plan to fix it resulting in an "emergency call"
2	Run to fail maintenance	The septic system has a condition that stops the system from working. The customer has some plan on what they can do to "get by" until a septic professional can get there.
3	Corrective maintenance	The customer notices that something is not correct and calls immediately before the problem worsens.
4	Routine maintenance	The customer is on a plan to have the system periodically checked (or checks it themselves) and follows the prescribed maintenance.
5	Preventive maintenance (Time)	The customer has the tank pumped and system checked on regular intervals. Whether it needs it nor not.
6	Preventive maintenance (Usage)	The customer monitors their home usage of toilets and other septic use and uses it for a guide on when to check the tank.
7	Condition-based maintenance	Maintenance is provided when there is monitoring in place that indicates that it is required. It does not specify which component nor how much time is left before a system failure.
8	Predictive maintenance	Hardware and software working together to anticipate a problem within a given time frame.
9	Prescriptive maintenance	Monitoring each component of the septic tank individually via computer and software. Conditions indicate in advance what component will fail, why it will fail, and diagnoses the specific part that is required, purchases it, and software schedules the replacement.

Appendix II – Sample Site Survey Questionnaire / Script

	Question	Explanation	Answer
1	Section I. Determine the parameters of the site and where the mounting location of the alarm would be.		
2	Where are the controls for the septic/grinder system mounted?	The wireless alarm would be mounted either where the existing controls are or to the side of the home. So, we like to understand where those are at. It connects to a float switch in the tank.	
3	Is there an open outlet located where the controls are mounted?	The new alarm will require 120V power.	
4	Is the available outlet live with power? Has it been checked?	The alarm needs power, and our typical installation does/ doesn't include that as part of the scope. If the outlet doesn't work, you will need to have that corrected for us to use it.	
5	How does power go from the existing controls to the septic / grinder?	There is usually a conduit that runs underground. We like to know how big that is and what is in it.	
6	How far is the septic /grinder system from the home?	A cable needs to be run from the septic to where the alarm will be mounted. We need know this distance so that we have the right length cable on the float switch that will be installed in the tank.	
7	Is there an outlet on the side of the home near to the septic/grinder?	If there is that may be a good potential spot to mount an alarm.	
8	Question 7 is yes: Is that outlet operational?	It may be a better location for the alarm if there is power at a closer point.	
9	Would you be willing to snap pictures of the septic/grinder location, the distance from the house, the existing controls, and if you can get a shot of the existing	This would be helpful to be sure that we are only quoting what is necessary. Additionally tree's and vegetation can be significant obstacles.	

	conduit at either end?		
10	Conclude the location with which location is closer to the septic/grinder that is to be monitored. If both are available, choose the shortest distance from the septic/grinder.	Okay, so you have power at (location X) and that is about ___ feet from the home, correct?	
11	Determine the type of wireless technology the customer prefers		
WI-FI Section			
12	Do you prefer an alarm that uses Wi-Fi or Cellular signal? (For Wi-Fi, go to next line, for Cellular go to line #17)	The benefit of cellular is that it works anywhere, but there is a downside in that it has an annual plan. Wi-Fi is free, but it does take some maintenance in terms of keeping it connected to your wireless network. Does one of those sound more desirable than the other?	
13	If the answer to 11 is “Wi-Fi”, Do you know is there Wi-Fi present at the septic tank?	Let me tell you how we can check this. If you go stand at the septic panel (or the side of house, whichever is closer). Turn off cellular data on your phone by going to SETTINGS> CELLULAR>CELLULAR DATA>OFF. † With cellular data off, open your browser and type “speed test” and let me know if the test completes.	
14	If the test in #12 completes	Wi-Fi is present at the area. With a Wi-Fi alarm it only works if there is Wi-Fi present, and we cannot control that, but the fact that the speed test completed with cellular data off is an excellent sign.	
15	If the test in #12 does not complete	The wireless alarm would not detect a wireless signal while mounted at that location. The customer can either use a cellular alarm or extend the wireless network to reach the proposed area.	
16	If cellular data was turned on for this test, remind the customer now to turn it back on. They will not receive text messages until it is on. SETTINGS>CELLULAR>CELLULAR DATA>ON		

Cellular Section			
17	<p>Do you know if you have cellular service there at your property?</p> <p>(If answer is No or customer does not know go to line #19. If answer is yes, proceed to next line.)</p>	<p>This test determines if cellular service is available in the area.</p>	
18	<p>Do you know who your cellular carrier is?</p>	<p>If you don't, you can find it by going into SETTINGS>CELLULAR>CARRIER SERVICES. It will display the cellular carrier right at the top of the page. ‡</p>	
19	<p>Do you have friends or relatives that visit that have different cellular providers? Can you find out what carrier they have?</p>	<p>Clarify if a cellular alarm is used the right carriers will available.</p>	
20	Conclude Wi-Fi or Cellular. If Cellular is not there, that cannot be fixed.		
21	<p>Customer has Wi-Fi Only (or is only interested in Wi-Fi)</p>	<p>Ok, that sounds like a Wi-Fi alarm would work fine for you. Do you have other Wi-Fi devices in your home? How many? Are you comfortable with changing passwords and things like that.</p>	
22	<p>Customer has Cellular Only</p>	<p>This points to using a cellular alarm, and it is known for certain that {carriers like AT&T, Verizon etc.} work on the property.</p>	
23	<p>Customer Has Both</p>	<p>Both options are available? Wi-Fi is a little more maintenance but has no annual fees. Is there a preference?</p>	
24	<p>Customer has neither</p>	<p>Unfortunately, there is neither cellular nor Wi-Fi. The lack of cellular signal cannot be fixed. Wi-Fi would require the purchase of a wireless extender to extend the network. We don't do that. that would be the only option. Is that something you want to do?</p>	
25	Conclude the Call		
	<p>Explain the hardware</p>	<p>We will take the information that you have given us and find the right product to include. So, we don't have that price now, but once we have your photos, we will have</p>	

		enough information to see if this is something that we can quote.	
	Explain the plans	here is generally the plan we have that would suit you would be ...	

Appendix III – Application Scenarios:

Scenario A: A municipality has a school for which it is very hard to predict demand on when to pump a tank. They are open to paying for a monitoring system such that the tank(s) will be pumped as needed based on conditional monitoring and takes no exception to monitoring fees. The installation has Wi-Fi and Cellular present. In this case, there are already regular billings in place. In this case, Complete Turnkey (P4) could be a good option.

Scenario B: The Jones Family has a septic tank they wish to monitor and have it pumped at a prescribed level. They have Wi-Fi present at the septic tank and have many other wireless devices in the home. They do not want an annual fee. The residence is located 30 miles from the operator's facility, and it would be undesirable to travel there to help Mrs. Jones change the wireless password. In this case the offering most suited to fit would be P2 Hardware and Installation.

Scenario C: Mr. and Mrs. Jackson live 51 miles from the office and are mostly off the grid. They have internet but its weak at the septic system. They use their internet only for their television and home phone. They like the idea of knowing when the tank needs to be pumped, and they are quick to admit that they're not tech savvy. If they have a Wi-Fi unit and it goes offline, they will call the office to ask how to put it back online. In this case, the goal would be to ensure that installing a wireless monitoring system does not become a disruption to the business of running a septic company. If the set-up is done for them, the Jacksons will be lacking the general knowledge of how the system operates. In this case, Cellular Plan 4 are options.

Scenario D: Mr. and Mrs. Stephens live remotely and there are only two members of the family. They call once every 7 years when the septic stops working, and the highest technology in their home is an AM radio. Mr. Stephens will never pay the surcharge for an emergency call and will simply "make do" until a standard scheduled service call can occur. This is probably not a scenario where deploying wireless technology is going to have a payback – or perhaps even work. In short, the customer and the septic operator must agree that smooth and reliable operation of the septic or grinder system is in their mutual interest.

Item	Appendix IV – Suggested Installation Equipment List
1	Drill with masonry bits for mounting to a concrete foundation.
2	Wall anchors for mounting a head unit (if not included in alarm)
3	A 50-foot pull cable for running the cable through an underground conduit
4	Wire Ties for holding the cable to the pump riser
5	Concrete cable anchors (i.e., the float needs to be suspended on a “bare wall”)
6	1” electrical conduit, couplings, and PVC glue (if applicable for a new conduit run)
7	Hammer drill with 1.5” masonry bit
8	1” Conduit Straps
9	Shovel

Appendix V – Understanding the G’s of Cellular and Wi-Fi

Cellular Overview

Cellular service has been evolving over time, and the evolution is considered in Generations, or G’s. There are enough cellular 5G commercials to be familiar with the terms. In the past there have been 2G and 3G products offered on the cellular market with very low cost. Presently we are working in the 4G and 5G generations, and 6G is likely more than a decade away.

The cellular technology jump from 4G to 5G was so significant that a milestone was established between them called LTE (Long Term Evolution). Inside of each generation (or “G”) there various bands. The knowledge that a septic operator needs on the cellular jargon is limited. 2G and 3G are “sunset” networks, meaning that in most locations in the US those technologies are going away. To give a customer a product that will have longevity limits the product offering to 4G, LTE, and 5G. Inside of those technologies there are various bands, the most typical for a stationary conditional monitoring application with limited data are CAT-M1 (also known as CAT-M) and CAT-1. Most of the technologies offered today will have one of these. Some older units that are 2G and 3G can be found. Depending on geography some may work for a customer today, however that connectivity can be eliminated at any time.

As cellular tech comes with a data plan there is the annual fees that come with them. Generally, the wireless alarm and the plan will come as separate payments (i.e., purchase the alarm, and after installation activate the data plan for an additional fee). One of the business aspects of cellular technology is that the plans can be offered to customers to create recurring revenue. The sensible approach is that the owner of the equipment also offers the plan. This is one of the advantages to the P4 turnkey approach. The owner can own the equipment and the plan and consolidate it into regular billings. The plan can be disabled, and with the right equipment it can redeployed to another customer. Devices are coming on the market in 2022 and we expect to see more in 2023 that have one plan but will automatically choose the carrier in the field. So, for example, if a device is deployed and only Verizon is available at that site, it will use Verizon. If the device is moved to another location that has only AT&T, it will use AT&T.

The drawbacks of cellular are dropping over time. Data costs are decreasing over time as can be seen in Figure 2 below. A standard cellular device would use about 0.5GB per year. There is margin available for re-sellers to capitalize on the data plans and create recurring monthly revenue, although it would take a large deployment to create a sizeable monthly revenue.

Customers appreciate several facts about cellular connectivity. There are no passwords to be lost. If power goes out to a home without a back-up generator, the wireless signal will be lost and if a problem occurs, they can still be notified as the cellular devices communicate directly with cellular towers that typically have back-up systems for power, thus cellular towers are known to continue to work during power outages.

Wi-Fi Overview

Like cellular, most Wi-Fi technology is also evolving. Equipment today broadcast 2 networks – 2.4G and 5G. In this case, the “G” is not for generation but for Gigahertz. It is the frequency at which the router transmits. Contrary to popular belief, 5G is not better than 2.4G it is just different, current routers have both.

As shown in Figure 1, the “superior” 5G offers more speed at the expense of range. Considering we are talking about septic and grinder pump monitoring, speed is not a concern for these devices, and it’s unlikely that a grinder or septic system is going to be found right next to a

wireless router. In some ways this is analogous to AM and FM radio. FM carries more data (i.e., better sound quality), but you can listen to AM radio while driving across two states without interruption.

Encouraging customers to put devices on a guest network is the best you can do. If they ask what a guest network is, you might suggest they call the device manufacturer, or their router manufacturer. It is the job of the equipment owner to fix the connectivity issues.

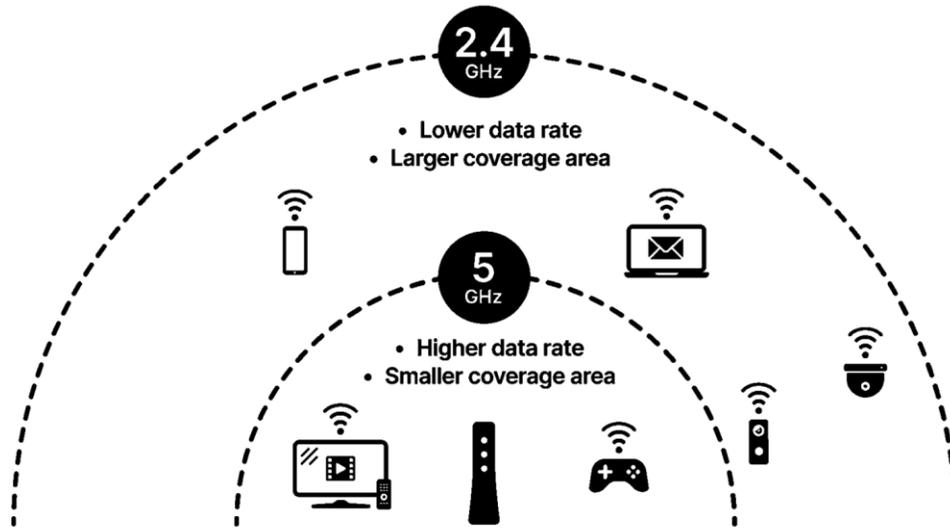


Figure 1- Wi-Fi 2.4G vs 5G

⁵ [Should I use 2.4 GHz or 5 GHz WiFi? | CenturyLink](#)

Appendix V - Power Loss

There are two principal subcategories of electrical power loss. Grid Power Loss and Circuit Power Loss. Grid Power Loss is when the entire home or a group of homes have lost electrical power. Circuit Power Loss relates to tripped breakers and GFCI's, where power to the home is still present.

Unplanned Grid Power Loss is (statistically) typically caused by weather. For information on any state and power outages, you can reference the U.S. Energy Information Administration⁶. The referenced article states that the average us power outage across the US is about 1:15. Some states (North Carolina) having more frequent and longer power outages due to hurricanes.

So, each technology and manufacturer may behave slightly differently in this scenario.

Table 4: Power Loss Information		
	Cellular	Wi-Fi
Grid Power Loss	<p>Cellular towers have back-up power that in most cases will last the outage of the duration.⁷ The exception may be flooding, hurricane, and fire where outages can last days or months. The tower may depend on a delivery of fuel to an onsite generator.</p> <p>If the local alarm has power coverage will continue.</p> <p>Most cellular products can provide notifications indicating that the product is offline and the cause.</p>	<p>Assuming the internet service to the home is provided by cable, the modem, router, and device need to have power for connectivity to continue.</p> <p>In this power loss situation, most products will alert that the product is “offline” due to loss of power or internet but will not give the specific information indicating which is the cause.</p> <p>The issue can be solved by adding a UPS to the modem and router.⁸</p>
Circuit Power Loss	<p>Depending on the alarm, some alarms will notify the owner specifically that the power is lost, and the unit is running on battery power. This should be investigated at time of purchase.</p>	

⁶ [U.S. Energy Information Administration - EIA - Independent Statistics and Analysis](#)

⁷ [California Blackouts Hit Cellphone Service, Fraying a Lifeline - The New York Times \(nytimes.com\)](#)

⁸ If a customer is interested in UPS, most routers use about 20 Watts, Modems use about 10 Watts, making the total 30 watts. If the customer plans for back-up power for 3-4 hours, the UPS will need to be sized for a minimum of 120WA (Watt-Hours).

In power-loss summary, when considering which product to put in a customer offering, the specific information on your state, the power outage frequency and reasons should be put into consideration along with the typical customer application. For example, does the customer suffer increased risk from grinder/septic back-up during significant weather conditions?