NC 811 Annual Report – 2020

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Suggested Citation

Al-Bayati, A. J., and Panzer, L. (2019) "Reducing Damages to Underground Utilities: Lessons Learned from Damage Data and Excavators in North Carolina." *Journal of Construction Engineering and Management*, American Society of Civil Engineers. 145 (12), DOI:10.1061/(ASCE)CO.1943-7862.0001724

Third-Party Damages

Third-party damages to the subsurface infrastructure are a major problem in the United States, often costing billions of dollars annually to repair or compensate for. In 2019, North Carolina 811 (NC 811) funded a research study to assess excavators' perspectives about the causes of utility damages. Subsequently, the study provides suggestions for how to prevent the incidents resulting from each cause. The study has been published in the American Society of Civil Engineers' *Journal of Construction Engineering and Management*. The article is entitled "**Reducing Damages to Underground Utilities: Lessons Learned from Damage Data and Excavators in North Carolina**." The study discusses the root causes of third-party damages, narrowing them down into three categories: excavators' insufficient practices, locators' insufficient practices, and no locate requests (i.e., excavators who fail to call the one call center). However, upon further investigation and analysis, a current article by Mr. Panzer and Dr. Al-Bayati that is under review suggests the following categories:

- Excavators' insufficient practices including no locate requests, invalid use of a locate request (e.g., wrong area was excavated), and failure to use hand tools to uncover subsurface utilities. In North Carolina, the following direct causes fall under this category:
    - No notification made to the one call center/811
    - Excavator dug prior to valid start date/time
    - Excavator failed to maintain clearance after verifying marks
    - Excavator dug prior to verifying marks by test hole (pothole)
    - Excavator provided incorrect notification information
    - Excavator failed to protect/shore/support utilities

    - Excavator dug outside area described on ticket
    - Improper excavation practice not listed above
- Locators' insufficient practices, including inaccurate marks and the absence of marks for a utility. In North Carolina, the following direct causes fall under this category:
    - Unmarked or inaccurately marked due to locator error
    - No response from operator/contract locator
- Utility owners' insufficient practices, including abandoned lines and inaccurate maps. In North Carolina, the following direct causes fall under this category:
    - Inaccurately marked or cleared utilities due to incorrect utility record/maps
    - Inaccurately marked due to abandoned utility
- Other causes that may be a result of general practices or work conditions. In North Carolina, the following direct causes fall under this category:
    - Marks faded, lost, or unmaintained
    - Unlocatable utility
    - Previous damage
    - Unmarked due to tracer wire issue

These insufficient practices not only cause damages but also compromise the entire one call system, as has been discussed in a recently published article by Mr. Panzer and Dr. Al-Bayati, entitled "**Reducing Damages to Underground Utilities: Importance of Stakeholders' Behaviors.**"

In North Carolina, the excavator must notify one call centers before work starts to request that the owners of involved utilities identify their underground utilities. This service was established to protect excavators and underground utilities from third-party damages. Utility

owners are required by the law to mark their subsurface utilities on the z-y plane within three full working days. Figure 1 illustrates the workflow that satisfies the North Carolina's Underground Utility Safety and Damage Prevention Act (i.e., the NC Damage Prevention Act).

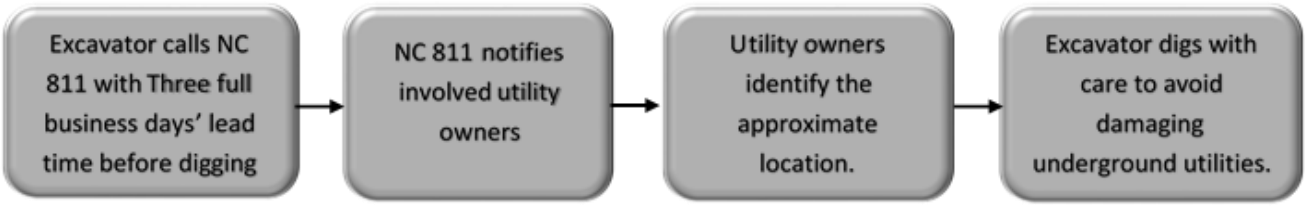


Figure 1. NC 811 Notification Workflow

In addition, Article 16 of the Occupational Safety and Health Act of North Carolina (OSHA NC) requires similar actions from excavators and utility owners. Accordingly, two of North Carolina's general statutes require three working days' notification before the proposed commencement of excavation. Otherwise, employers may be cited by OSHA NC or through a complaint process to the Underground Damage Prevention Review Board.

When underground utilities are damaged, North Carolina's Underground Utility Safety and Damage Prevention Act requires the excavator to contact the Notification Center (i.e., NC 811) and the facility operator/owner, if known, to report the location and nature of the damage.

Number of Damages Reported in 2019

There were 15,621 reported damage incidents in the state of North Carolina in 2019. This indicates a greater number of reported damages than in the previous three years, as shown in Table 1.

Table 1. The Number of Reported Damages to NC 811

Year	2019	2018	2017	2016
Number of Damages	15,621	12,024	11,160	15,171

The number of damage incidents reported by Common Ground Alliance (CGA) is higher. CGA reported 38,599 damage incidents in North Carolina. Figure 2 shows the number of damage incidents reported to NC 811 and CGA by utility type. Most of the differences occurred within tele/CATV damages. Like what has been suggested in NC 811's 2018 report, the difference in the number of damages could have resulted from the failure of tele/CATV locators in North Carolina to report damage information to NC 811, which is a violation of the NC Damage Prevention Act.

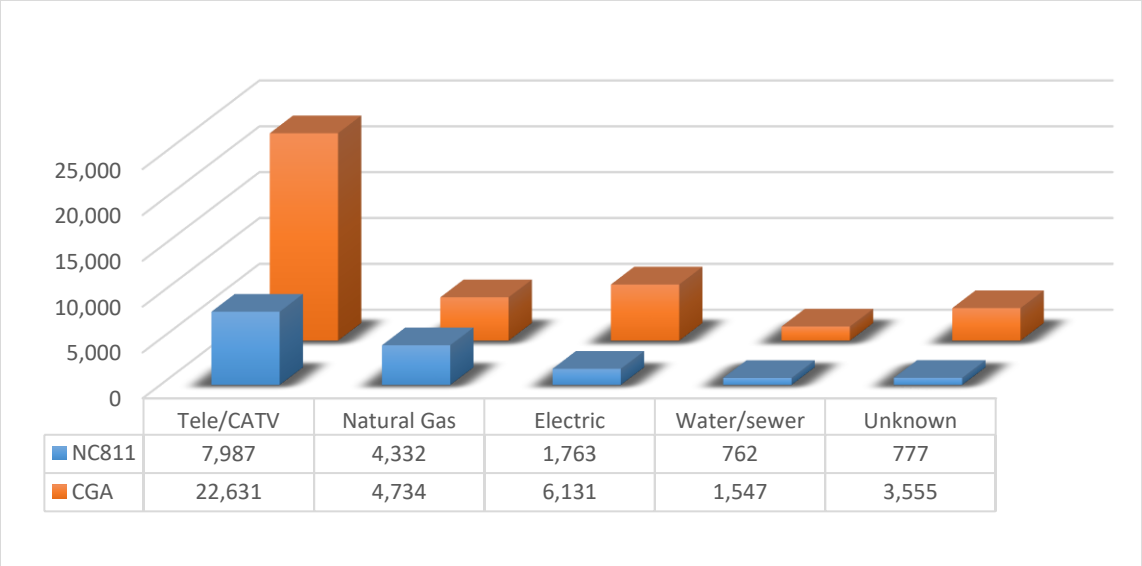


Figure.2. The Number of 2019 Damages in NC (NC 811 vs. CGA)

Direct Causes

Trends among reports to NC 811 are discussed in this section. As has been discussed earlier, this report categorizes the primary cause of damages as follows: excavators' insufficient practices, locators' insufficient practices, utility owners' insufficient practices, and others. The direct cause has been reported in only 6,036 reports. The proportions of each case category are presented in Figure 3 based on the data reported to NC 811 without the unknown inputs. The data indicates that excavators' practices contribute to more than 70% of underground damages in North Carolina. Failure to notify the one call center represents 80% (3,561) of direct causes within the locator practices category and 59% of all reported direct causes. The cause categorization presented in this report is being used for the first time. Thus, it is not possible to compare the 2019 causes with causes reported in the previous NC 811 reports and CGA's DIRT reports.

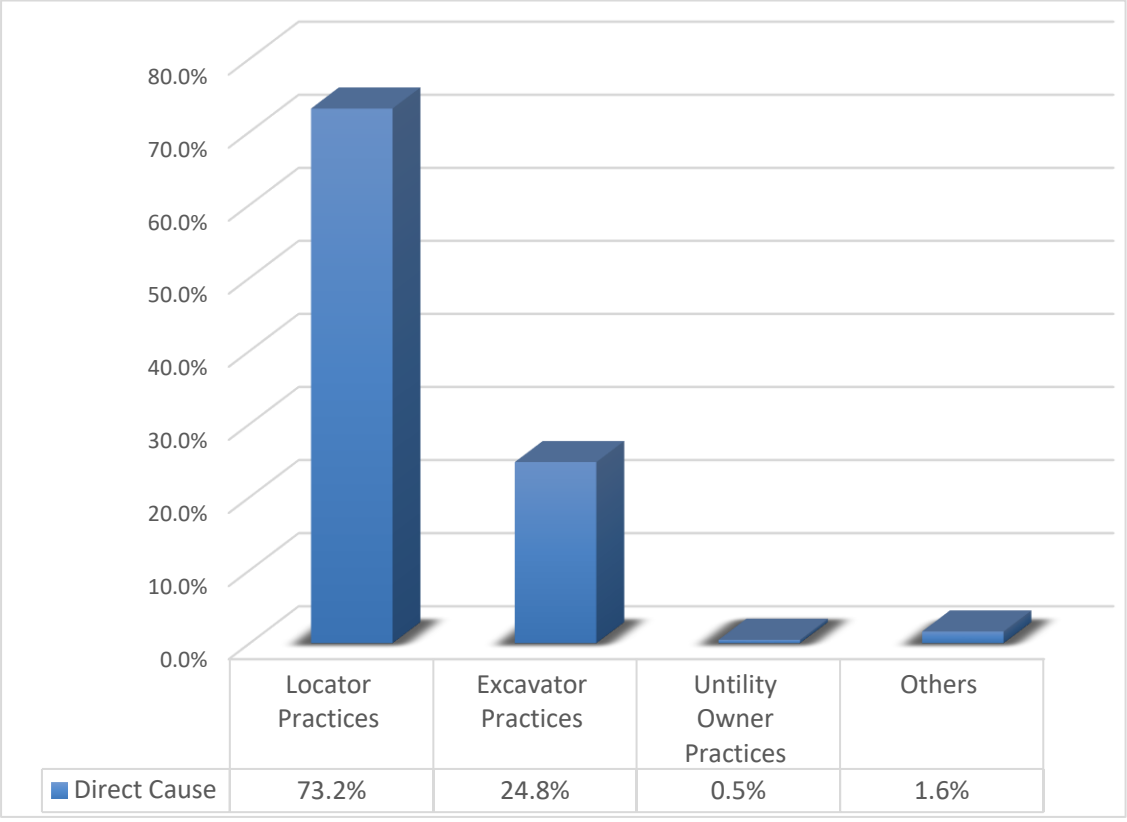


Figure 3. Direct Cause Proportions

General Trends

It is anticipated that one can obtain accurate damage trends using NC 811 data because a trend could be captured through a random representative sample.

No Locate Requests

NC 811 was created to ensure that all underground utilities will be marked before the excavation starts. However, this is only possible when excavators notify NC 811. The 2019 dataset suggests that 3,561 damage incidents (22.8%) were not associated with a locate request. The 2018 dataset shows that 2,408 damage incidents (20%) were not associated with a locate request. This percentage is higher than those obtained in 2018 (20%, 2,408 damage incidents), 2017 (19.4%, 2,169 damage incidents), and 2016 (21.56 %, 3,271 damage incidents).

The examination of no locate requests indicates that most of the cases occurred in Mecklenburg County (33.4%), followed by Guilford County (13.5%), Wake County (7.2%), and Forsyth County (4.2%). Comparing these percentages with previous years' percentages shows an overall increase in no locate requests in Mecklenburg and Guilford, see Table 2. The percentages from Guilford County show a continuous increase over the years, which requires special attention. NC 811's educational and outreach efforts should target Guilford County. NC 811 education comes in a variety of methods such as advertisements (e.g., billboards and television advertisements), onsite training by NC 811 educators, and the PIPES Plus online platform.

Table 2. No Locate Requests by Major County between 2016 and 2019

County	Mecklenburg	Wake	Durham	Guilford
2019	33.4%	7.2%	2.4%	13.5%
2018	25.40%	9.96%	3.70%	8.68%
2017	23.10%	17.38%	5.53%	4.52%
2016	28.12%	18.52%	6.14%	4.49%

Examining the data of no locate requests by excavator type reveals that the highest percentage of no locate requests within the known dataset was among contractors (79.8%) and was higher than last year's percentage, which was 45.2%. The firms that did not place a locate request were mainly perform landscaping and waterworks which is similar to the reports from 2019. Accordingly, this finding highlights the specific sectors that NC 811 needs to target through educational and outreach efforts.

Damages per County

The NC 811 damages per county show that higher percentages (i.e., more than 4%) of reported damages occurred in Mecklenburg County (21.79%), followed by Wake County (15.45%), Guilford County (7.26%), and Durham County (5.19%). The 2017 report suggested that higher percentages of damages are expected in these counties because excavation work has increased significantly in Mecklenburg, Wake, and Durham since 2015. When comparing the 2019 percentages of damages per county with percentages from previous years, a continuous increase in the rates was noted again in Guilford County, which requires further investigation, see Table 3. The data also show an increase in no locate request in Guilford, see Table 2.

Table 3. Damages Percentages by Major County

County	Mecklenburg	Wake	Durham	Guilford
2019	21.79%	15.45%	5.19%	7.26%
2018	21.94%	16.32%	5.14%	5.82%
2017	26.09%	19.87%	5.39%	4.36%
2016	33.35%	21.46%	6.62%	3.96%

Employer Type

An excavator is a person engaged in excavation or demolition. There are also several types of employers, such as contractors and utility owners, who hire excavators to perform an excavation. Contractors caused the most damage to underground utilities in 2019, accounting for 74.03% of damage incidents (11,565), followed by municipalities (4.33%, 677 damage incidents) and utility owners (2.62%, 409 damage incidents). These rates are similar to those reported in 2019. Table 4 shows the number of damages per service type caused by the three employers. Figure 4 illustrates the percentage of damages to underground utilities per the major three employers who caused the most damages. On the other hand, the work performed by contractors fell within the following categories: telecommunication (2,438, 23.75%), electrical (1,490, 14.52%) water (1,421, 13.84%), and natural gas (1,279, 12.46%). Finally, Table 5 shows the services affected due to the damages. The service types are classified as transmission, distribution, and service lines. Transmission lines carry the service such as electricity, clean water, and natural gas to distribution lines that carry services to customers through the service lines.

Table 4. Number of Damages per Employer and Service Type over the Years

	Contractors			Utility Owners			Municipalities		
Year	17	18	19	17	18	19	17	18	19
Tele CATV	4,321	2,597	6910	337	221	326	445	229	478
Electric	1,055	4,013	1660	32	23	17	39	83	42
Water & Sewer	659	583	733	14	7	11	9	13	7
Natural Gas	2,434	1,470	1679	55	62	45	163	94	86
Total	8,469 (78.8%)	9,062 (75.4%)	11565 (74.03%)	438 (4.07%)	325 (2.7%)	409 (2.62%)	656 (6.33%)	527 (4.8%)	677 (4.33%)

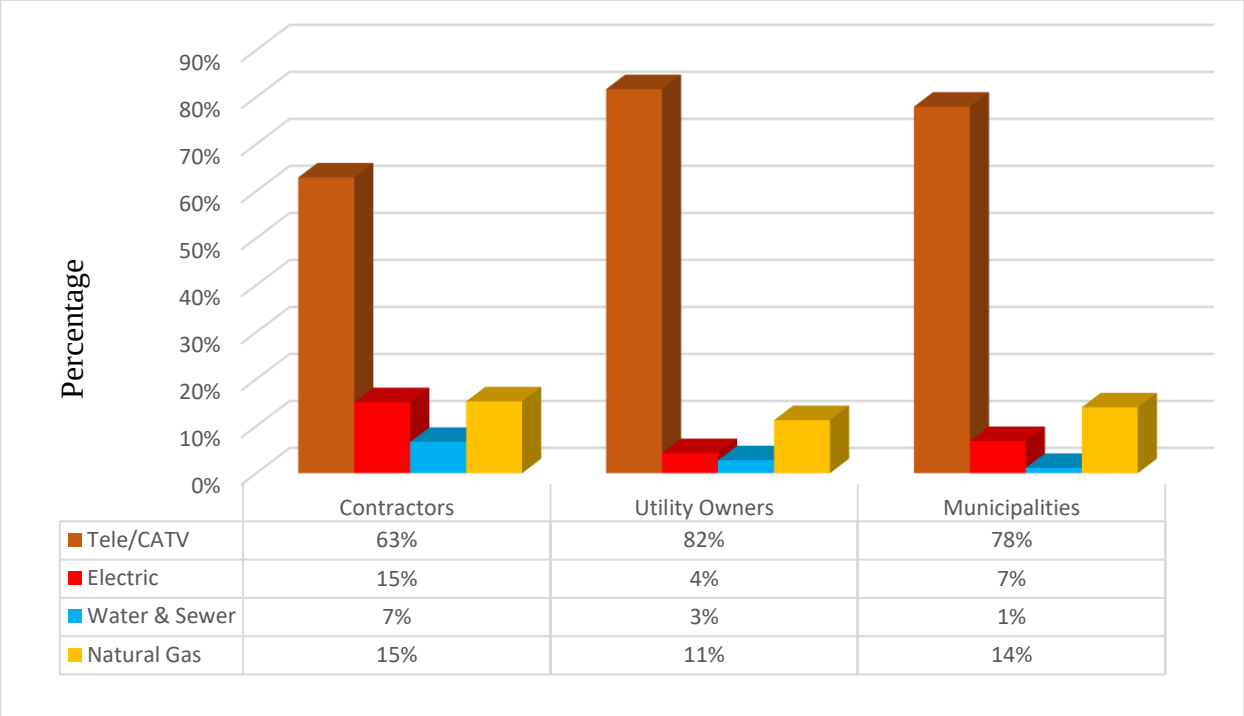


Figure.4. Damages to Underground Utilities per Employer Type

The overall data indicate consistency in affected service types across major employers. The table also shows a reduction in the number of damages to transmission lines by contractors when compared to 2018. It is also clear that damages to transmission lines represent a small percentage of the overall damages reported. Transmission lines are deeper and better marked in private rights-of-way (ROW). Furthermore, transmission lines that are not in private ROWs are usually along busy roads, not in neighborhoods. In addition, Transmission Integrity Management has required pipeline personnel to be present during excavation to satisfy the Pipeline and Hazardous Materials Safety Administration (PHMSA). The higher risk of injury and the potential cost of disruption to the transmission lines make these utilities a higher priority to the owners.

Table 5. Affected Services per Type of Employer

	Contractors		Utility Owners		Municipalities	
Year	2018	2019	2018	2019	2018	2019
Service	3253 (51%)	4048 (51.4%)	212 (66%)	228 (78.1%)	170 (73%)	247 (66.2%)
Distribution	2959 (46%)	3707 (47.1%)	98 (31%)	60 (20.6%)	57 (25%)	111 (29.8%)
Transmission	174 (3%)	117 (1.5%)	10 (3%)	4 (1.3%)	5 (2%)	15 (4.0%)

Damages per Work Performed

This section investigates damages per work type, within known data, to reveal whether there is a type of work that contributes more than others to underground utility damages. The results suggest that most of the damage incidents occurred while conducting tele/CATV work, followed by

water/sewer work, electrical, and natural gas, see Figure 5. On the other hand, Figure 6 between damages reported in 2018 and 2019 in terms of work type. Clearly, electrical work contributed more to damages in 2019 than in 2018.

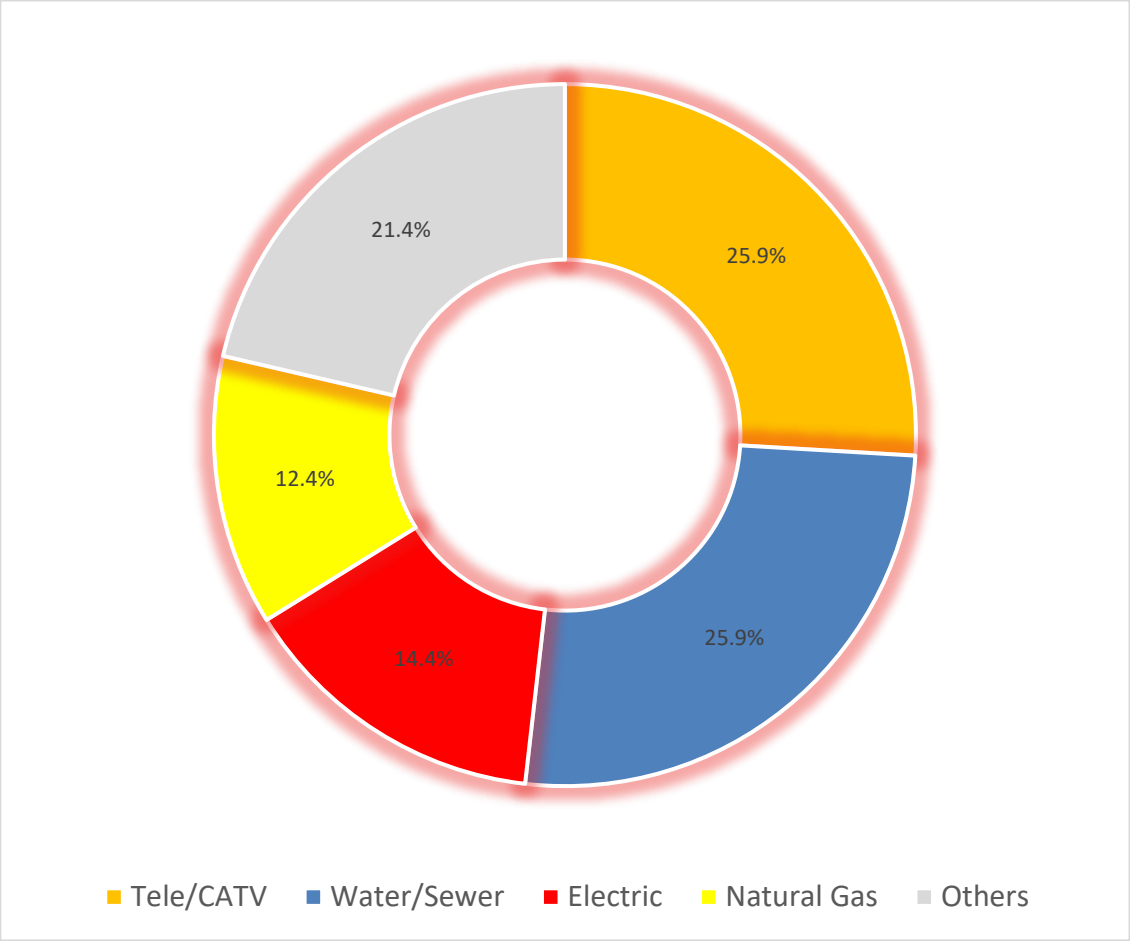


Figure 5. Damages per Work Performed

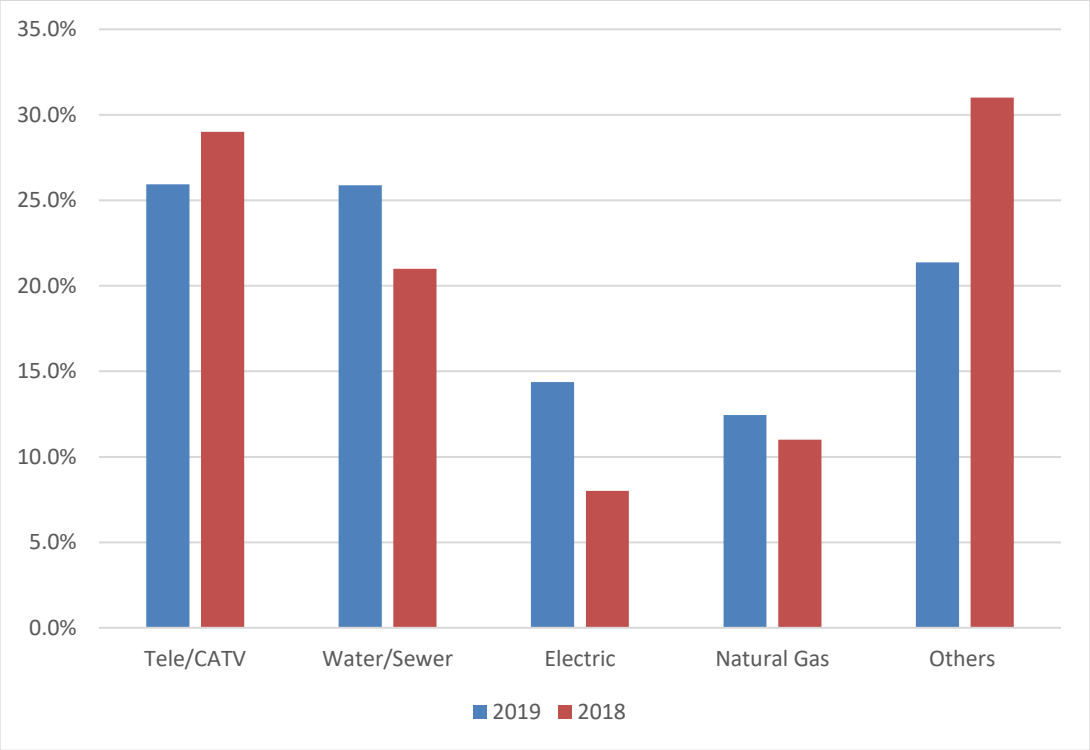


Figure 6. A Work Performed Comparison 2019 - 2018

Table 6 shows the percentages of work performed that lead to damages to major utilities. As can be seen, the percentages of work that led to gas damages are small because most of the investigated data do not show the nature of the work performed. Overall, tele/CATV work contributes to higher percentages of damages than other types of work, including water/sewer, the lines for which are often located deeper than tele/CATV utilities. However, the increased use of horizontal directional drilling (HDD) could explain the high contribution of tele/CATV. In recent years, HDD has become the method of choice for installing new underground utilities due to its minimal impact on the surface area and its competitive cost. Thus, using HDD to install tele/CATV may place these lines deeper than customarily expected, which may lead to conflicts with existing lines and a higher rate of underground damages.

Table 6. The Percentages of Work Performed per Damaged Facility

Damaged Utility	Tele/CATV	Electric	Gas	Water/Sewer
Work Performed				
Tele/CATV	19.60%	22.50%	12.20%	62.20%
Water/Sewer	25.00%	26.80%	7.20%	3.90%
Electrical Work	14.70%	8.68%	4.60%	10.80%
Gas Work	12.40%	14.80%	2.30%	7.80%

Positive Response Trends

A ticket is created after each notification received by the NC 811 notification center from an excavator. NC 811 transmits the received notification to the affected utility owners. Several transmissions are typically associated with each ticket (roughly a 5:1 ratio of transmissions to tickets). Out of the 100 counties in the state of North Carolina, 53.7% (i.e., 8,411,047) of the 2019 transmissions were placed in the following counties: Mecklenburg (3,093,651), Wake (2,483,014), Guilford (945,214), Durham (850,565), Forsyth (587,288), and Buncombe (451,315). Figure 7 shows the proportions of transmissions in these counties between 2019 and 2018. Positive responses are a requirement under the law and a method for the members of NC 811 to provide information to excavators regarding their ticket. The most frequent positive responses during 2019 were Code 10, followed by Code 20, Code 30, Code 999, Code 80, and Code 60, see Table 5. It seems that Code 30 has been utilized slightly more in 2019.

The data indicate that 47.4.5% of positive responses required more than the regulatory time, which is three business days in the state of North Carolina. This percentage is 11% lower than the 2018 percentage. The numbers of business days (BDs) that were needed to provide a positive response in 2018 and 2017 are presented in Figure 9, which shows a noticeable improvement in the time needed to deliver a positive response.

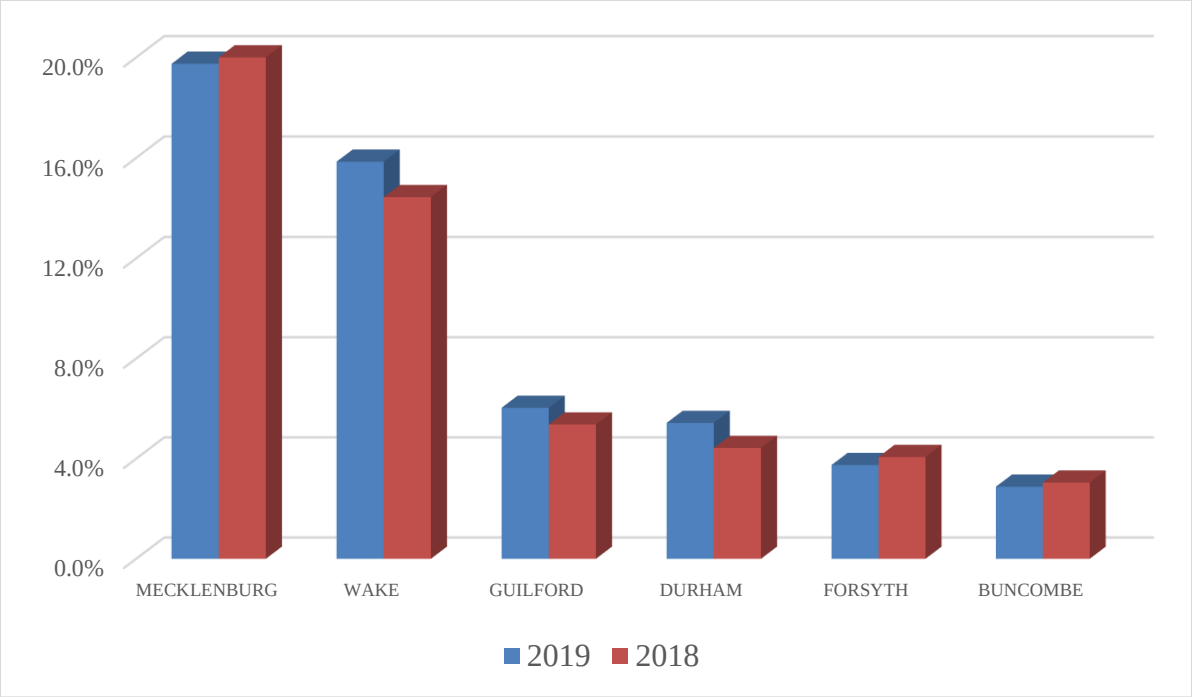


Figure 7. Positive Response Percentages by Major County 2019 – 2018

Table 5. The Most Frequent Codes in 2018

Code	Number (%)		Code Meaning
	2018	2019	
Code 10	5,429,760 (39.7%)	6,318,607 (40.3%)	No conflict, the utility is outside of the stated work area
Code 20	4,547,857 (33.2%)	5,001,258 (31.9%)	Marked
Code 30	1,143,720 (8.36%)	1,843,619 (11.8%)	Not complete
Code 999	1,003,417 (7.34%)	1,616,907 (10.3%)	Member has not responded by the required time
Code 60	856,923 (6.27%)	223,167 (1.4%)	Locator and excavator agreed and documented the marking schedule
Code 80	336,570 (2.46%)	334,547 (2.1%)	Member's master contractor is responsible for locating facilities

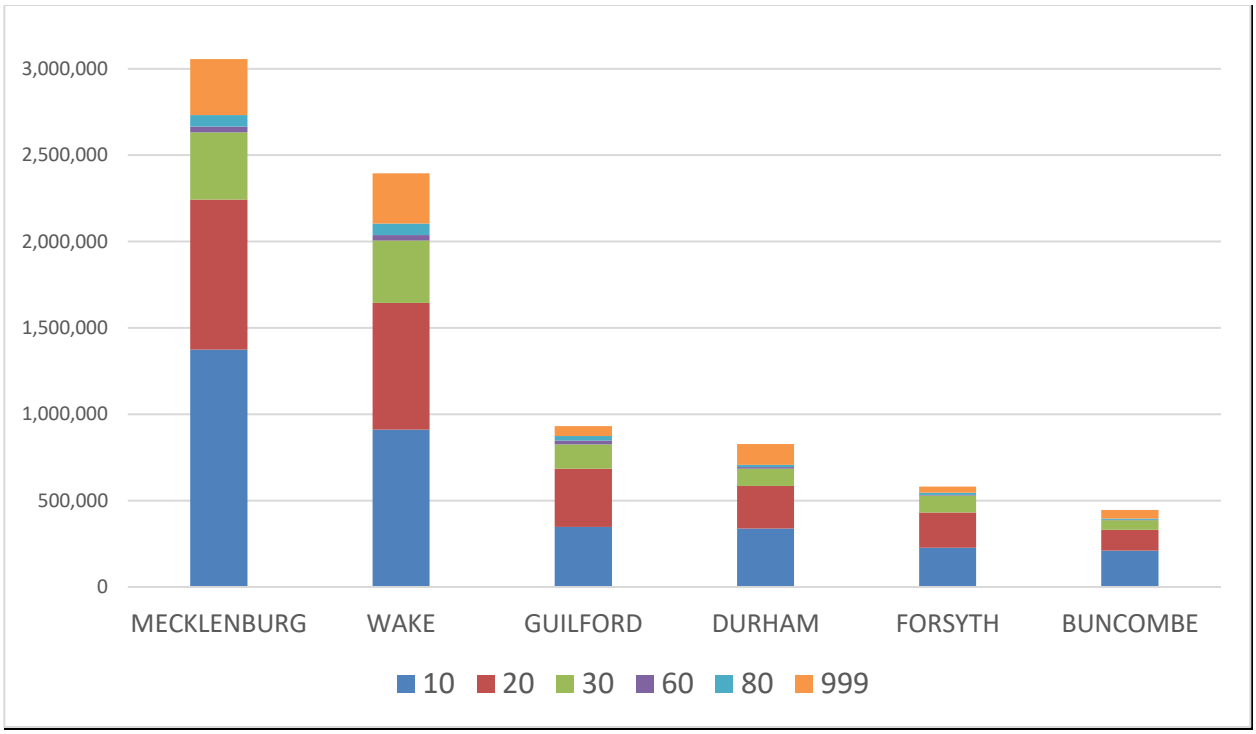
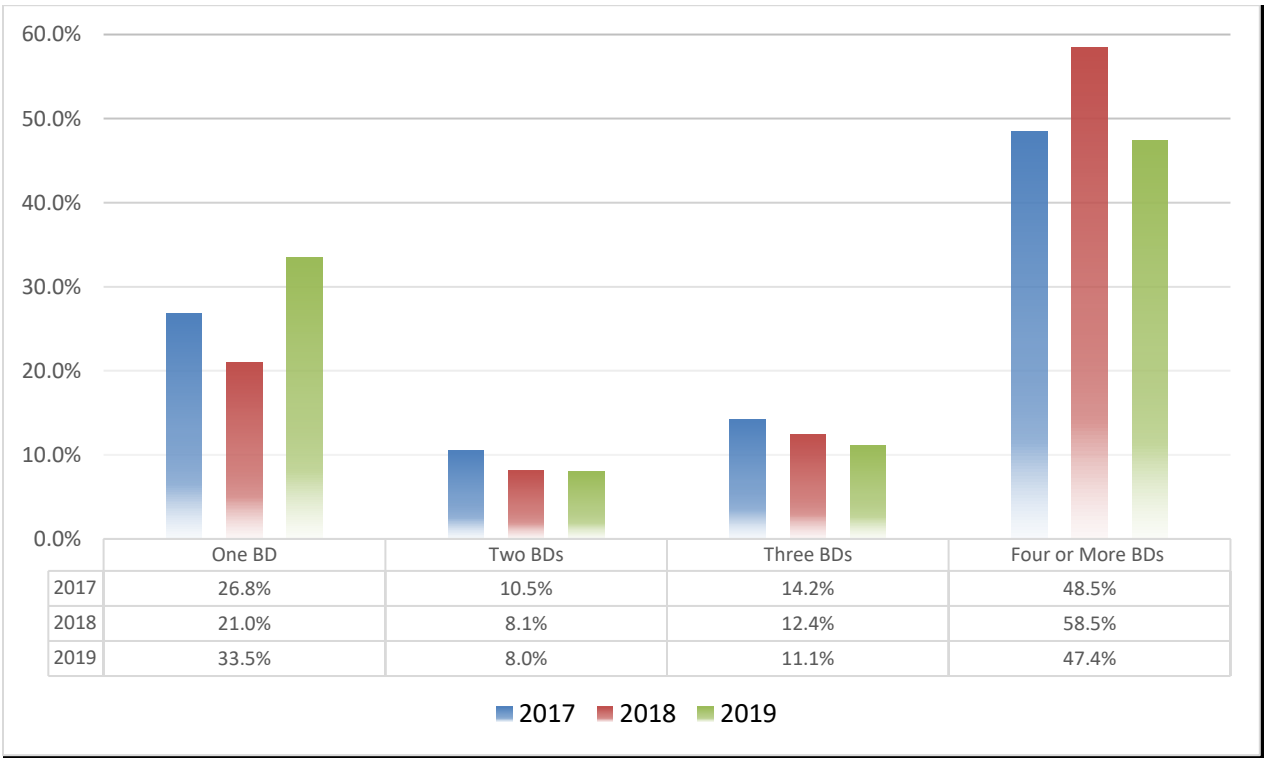


Figure. 8. Percentages of Major Codes by County



	One BD	Two BDs	Three BDs	Four or More BDs
2017	26.8%	10.5%	14.2%	48.5%
2018	21.0%	8.1%	12.4%	58.5%
2019	33.5%	8.0%	11.1%	47.4%

Figure. 9. The Number of Days Needed for a Positive Response

Three-Hour Notice (3Hr) and Code 999

The utility owners must mark their utilities within three business days (BDs) according to the damage prevention act in the state of North Carolina. Excavators shall place a three-hour notice (3Hr notice) when utility owners fail to mark their utilities within three BDs [87–122, (C) (2)]. Code 999 is assigned to a ticket when utility owners do not respond within the required time. In 2018, 53.7% (i.e., 8,411,047) of transmissions occurred in Mecklenburg, Wake, Guilford, Durham, Forsyth, and Buncombe. The percentages of the 3Hr notices and Code 999 in these counties represent 57.5% and 54.2% of the total count, respectively. Comparing the overall number of 3Hr and 999 Codes in these counties indicates that the 3Hr notice is not fully utilized. For example, the number of 999 Codes in Mecklenburg was 322,987, whereas the number of 3Hr notices was only 20,906, which suggests failure to use the 3Hr notice and/or invalid use of the Code 999, see Table 6. Thus, educational and outreach efforts should clearly explain the importance of utilizing the 3Hr notice.

Table 6. The Number of 3Hr Notices and Code 999

County	2018		2019	
	3Hr	Code 999	3Hr	Code 999
MECKLENBURG	15,761	235,065	20,906	322,987
WAKE	9,720	158,161	18,777	290,714
GUILFORD	2,193	39,807	4,570	57,046
DURHAM	2,767	69,056	5,323	120,266
FORSYTH	2,926	20,531	2,654	35,250
BUNCOMBE	1,056	40,596	2,453	49,624

The Sources of Damage

The damage sources section is a new addition to NC 811 yearly report. It could be defined as the object or substance motion that directly produced the damages. Within the known data, Backhoe and Trackhoe (6092; 54.4%) contribute the most to damages to subsurface utilities, followed by Hand Tools (2190; 19.5%), Boring (1031; 9.2%), Trencher (470; 4.2%), Directional Drilling (449; 4%), and Drilling (398;3.6%). However, it is difficult to justify the high proportion of hand tools without a third-party damage investigation.

2020 Follow Up Survey

This section will discuss the findings of the 2020 follow up survey that have been funded by NC 811 and conducted through a collaboration with Construction and Safety Management, LLC. The 2020 follow-up survey was administered during May 2020, with a total of 279 responses received; 25.3% of responses were from first-time callers. Roughly, half of participants were homeowners (130; 46.6%), followed by special trades contractors (67; 24%), civil and heavy contractors (38; 13.6%), residential builders (21; 11.1 %), agriculture industry (12; 4.3%), and manufacturing industry (1, 0.4%). Figure 10 illustrates the method used by participants to place a locate ticket. Calling NC 811 via phone is the most used method within the study sample. A similar trend has been noted in previous NC 811 research studies. The participants were asked about the easiness of placing a locate ticket through NC 811. The collected data suggest that 96.1% of participant believe it is easy to place a locate ticket. Table 7 lists a sample of reasons as why 3.9% of the study sample believe it's not easy to place a locate ticket. On the other hand, the frequencies of contacting NC 811 within the study sample are presented in Figure 11. Through this report a special attention will be paid to the 21.2% of participants who contact NC 811 at least once a month.

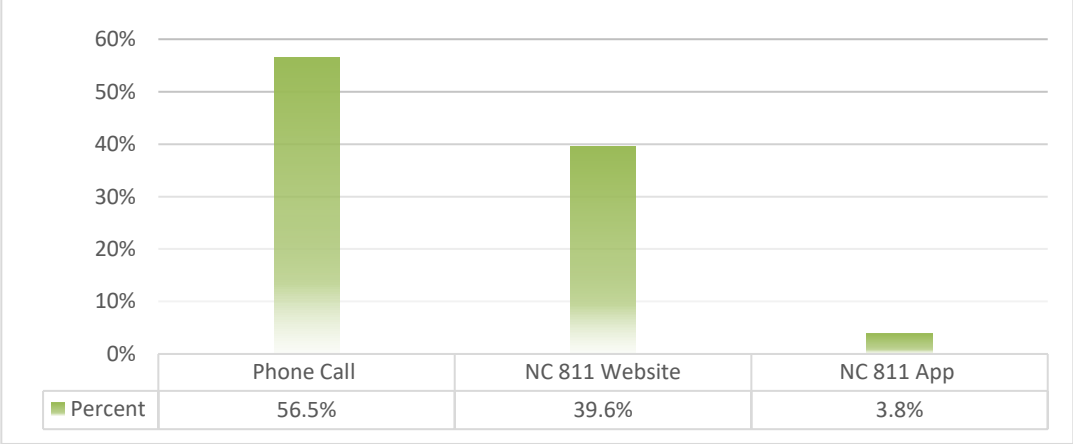


Figure. 10. The NC 811 Contract Method

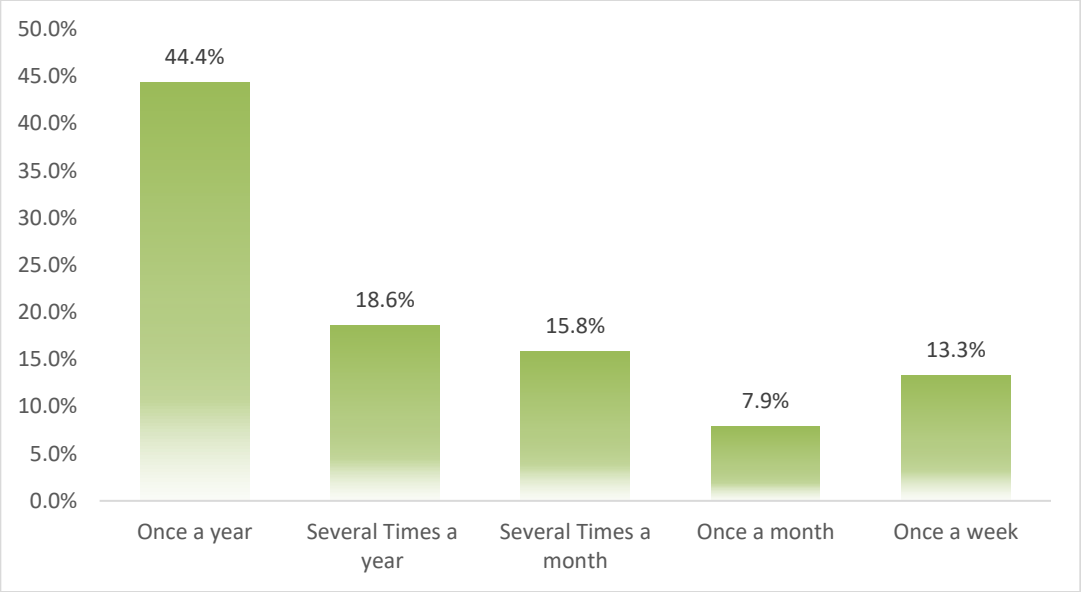


Figure. 11. The Frequency of Contacting NC 811

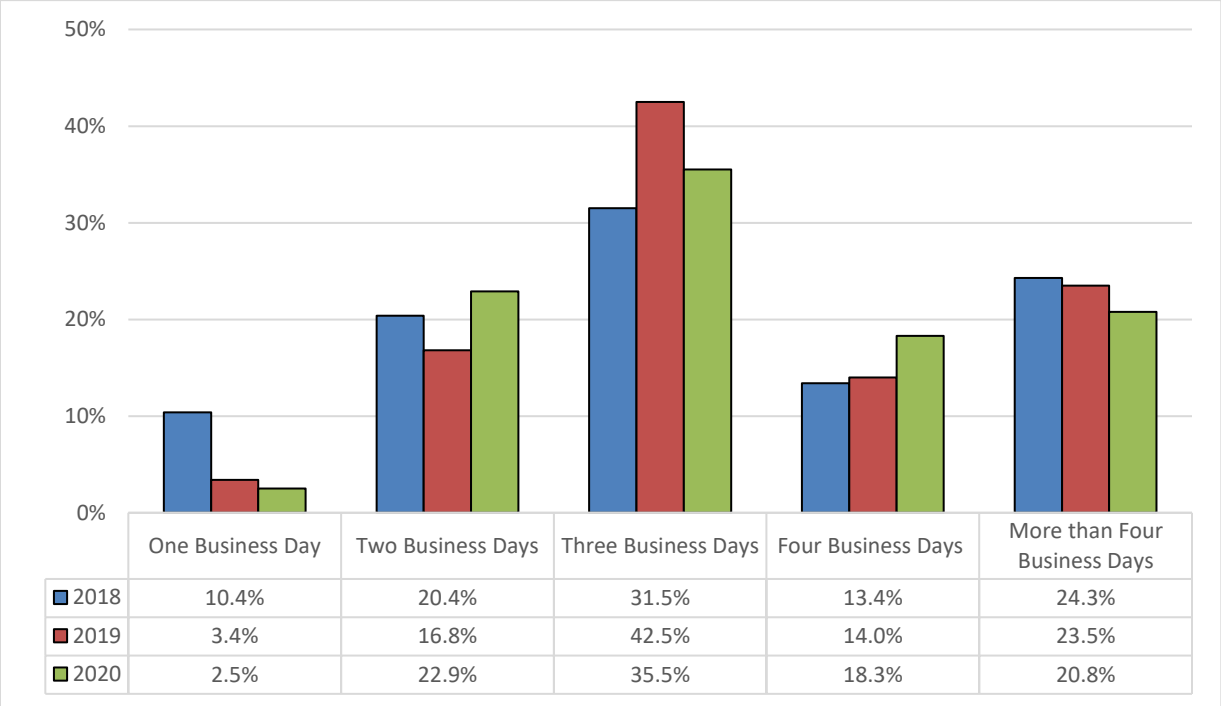
Table 7. Sample of Participants Feedback – Ticket Information

• It is challenging because there is nowhere to describe the conditions of the locate. For example, a property has an easement and has a different address than the property it is located on. There is nowhere to put Gate codes for access to the location property. There is no place to Upload a schematic of a redline map for reference.
• It was confusing what NC811 was going to do and what more I had to do. Even talking on the phone, it was just not totally clear.
• Need an easier way to pinpoint location may be a map you could set a pin etc. instead of old school between this road and x amount of ft from this road etc. Most construction sites do not have an address and need locates the most.
• Takes too long Spelling every word is too time-consuming even to update
• The website and the phone operator both initially told me the address didn't exist, despite the fact the home was over 40 years old.
• Providing coordinates or a map would save a lot of time for all parties.

The Survey Findings

The locating accuracy seemed to satisfy the individuals who participated in the study since 82.1% of them stated that the locating marks were accurate. This percentage was 87.9% in the 2018 survey, which could be considered an acceptable variation that should be further monitored.

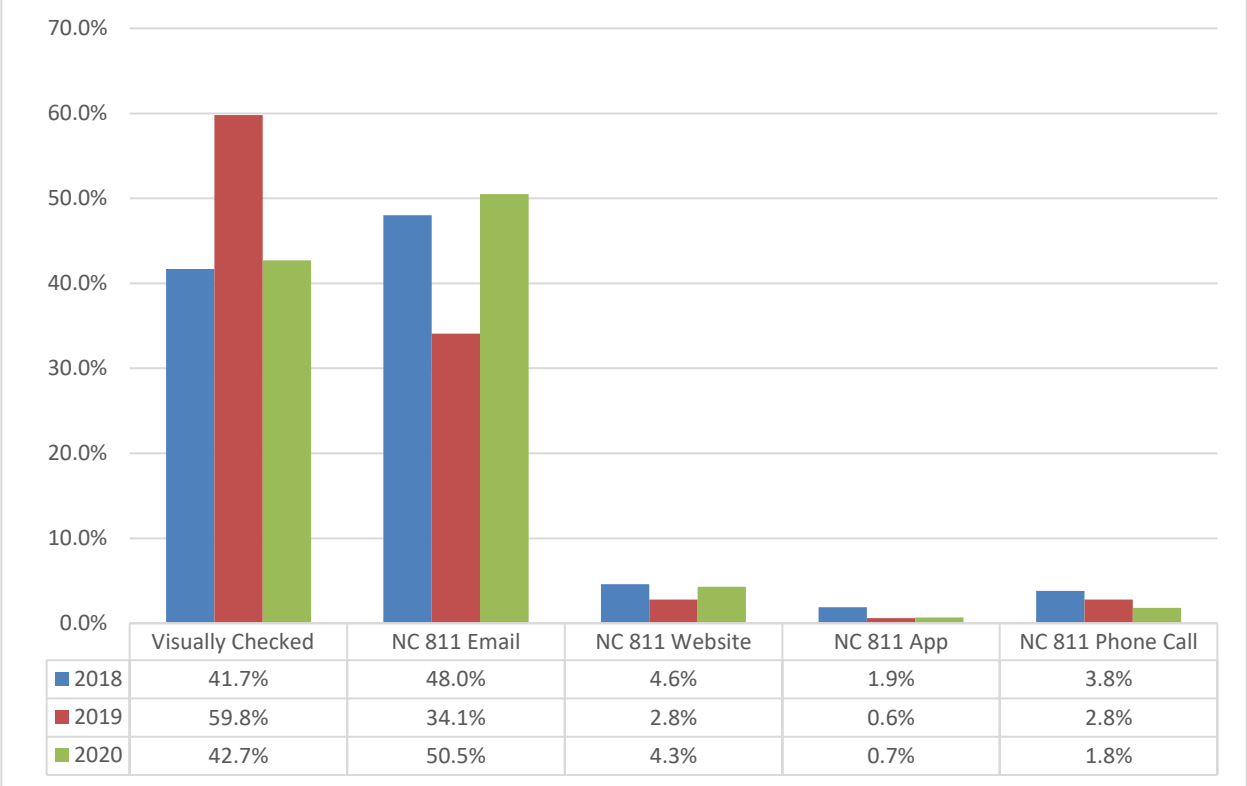
Findings of this survey also suggest that utility locators are often unable to complete locates within the legislated time in North Carolina (i.e., three business days). Figure 12 shows the number of days that were needed to locate underground utilities based on the participants' experience in 2020. The results indicate that 39.1% of locate requests were not fulfilled within the legislated time. This percentage is trivially higher than the percentages of the 2018 and 2019 Follow-up Surveys, which were 37.7% and 37.5%, respectively. Excavators must give three-hour notice when locators fail to mark their utilities within the legislated time [§87-122, (C) (2)].



	One Business Day	Two Business Days	Three Business Days	Four Business Days	More than Four Business Days
2018	10.4%	20.4%	31.5%	13.4%	24.3%
2019	3.4%	16.8%	42.5%	14.0%	23.5%
2020	2.5%	22.9%	35.5%	18.3%	20.8%

Figure. 12. Number of Days Needed to Locate Underground Utilities

On the other hand, the survey results indicate that many participants have used an incorrect approach to check the locating status (i.e., visual inspection of the proposed excavation area). Individuals who place a locate ticket with NC 811 should be sure all underground utilities have been marked by checking with NC 811 via phone, email, or through NC 811 website. The results, however, indicate that 42.7% of participants only visually checked excavation areas to check the status of their locate request, followed by receiving an email from NC 811 (50.5%), see Figure 4. Checking the excavation area alone is not sufficient to check the locate request status. Besides, it is a violation of article §87-122. (a) (2) of the Damage Prevention Act in North Carolina, which requires excavators to confirm the positive response through NC 811. However, the NC 811 research studies suggest that this method is widely used by participants which indicates the need to highlight it in NC 811 educational efforts, see Figure 13.



	Visually Checked	NC 811 Email	NC 811 Website	NC 811 App	NC 811 Phone Call
2018	41.7%	48.0%	4.6%	1.9%	3.8%
2019	59.8%	34.1%	2.8%	0.6%	2.8%
2020	42.7%	50.5%	4.3%	0.7%	1.8%

Figure. 13. Checking Positive Responses Method

The Quality of Services Provided

This section assesses the quality of the NC 811 process, the professionalism of NC 811, the accuracy and completion time of locate requests, and the professionalism of locators. The results suggest that the professionalism of NC 811 scored higher than other aspects, which is similar to the results of the 2018 Follow-up Survey, see Figure 14. The average scores of the 2020 survey for all aspects are in consistence with the 2018 survey. Overall, the finding indicates that participants believe the NC 811 professionalism in handling locate requests is better than the entire "Call before you dig" process.

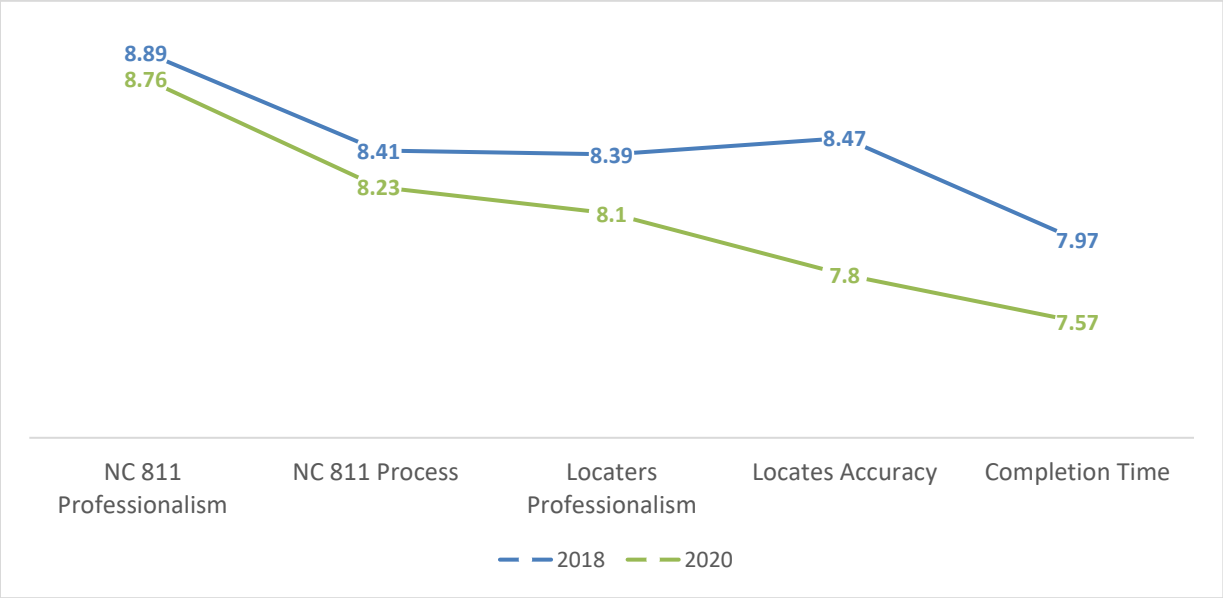
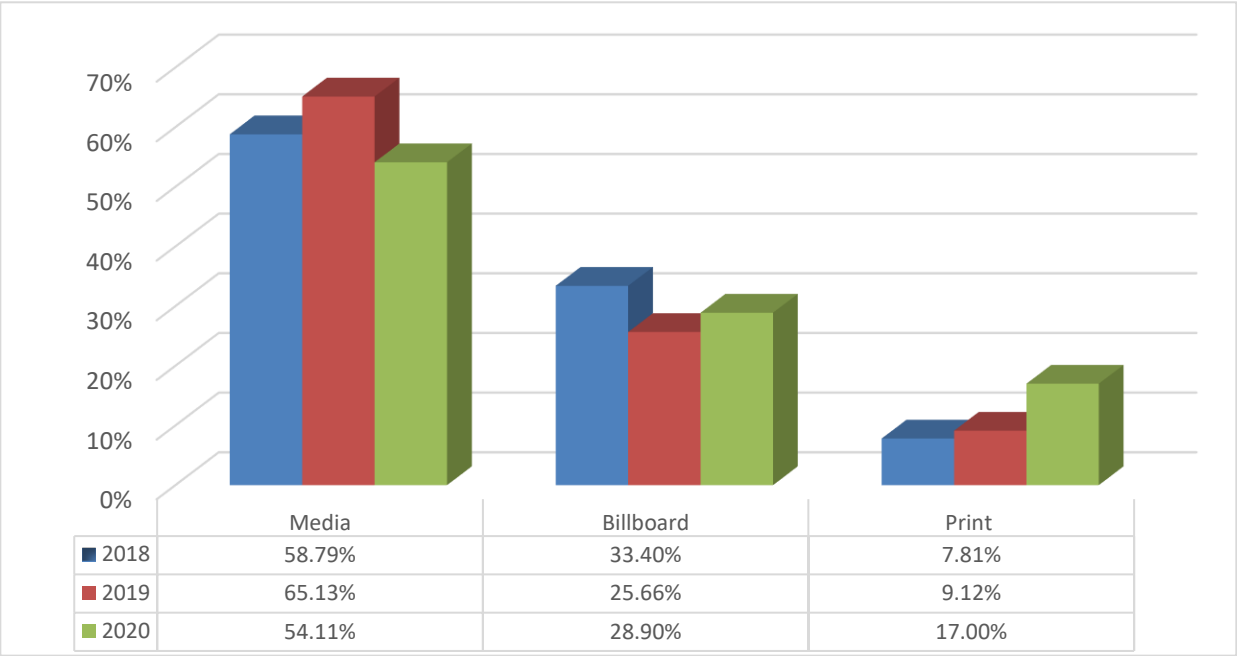


Figure. 14. The Average Quality based on Participants' Experience

NC 811 Outreach Efforts

North Carolina 811 works hard to educate the citizens of North Carolina about its services. The education efforts come in different formats, such as billboards, TV, and radio advertisements. Figure 6 illustrates the most effective methods of education based on the participants' feedback. Within the obtained data, media, which includes television, radio, and internet advertisement, represents the most effective method of outreach with a share equaled to 54.11%, followed by

billboard 28.9%, and print 17%. Print, which includes magazines, phonebooks, and utility bills, seems to be more popular this year than the previous years, see Figure 15. The overall findings should contribute to shaping future outreach efforts, as well as funding.



	Media	Billboard	Print
2018	58.79%	33.40%	7.81%
2019	65.13%	25.66%	9.12%
2020	54.11%	28.90%	17.00%

Figure. 15. Effectiveness of Outreach Methods

The Demographic Profile and Practices of Professional Participants

The percentages of employees within the firms participated in the study were as follows: 71 (48%) had less than ten employees, 45 (30.4%) between 10 and 50 employees, 15 (10.1%) between 50 and 100 employees, and 17 (11.5%) more than 100 employees. Thus, most of the respondents represent establishments that hire less than 50 employees and could be classified as smaller construction firms. However, the revenue of respondents' employers varies. The revenue of 29 (19.5%) employers was less than $100,000 per year, 32 (21.5%) employers had between 100K and 500K, 25 (16.8%) between 500k and 1 million, 29 (19.5%) between 1 and 5 million, and 34 (22.8%) more than 5 million. Sixty-two of the respondents (41.6%) indicated that they utilize methods other than NC 811 to locate underground utilities such as 3rd party locator, their own

locate equipment, and training frontline supervisors to look for signs of unmarked lines. Furthermore, the participates were asked if the COVID-19 situation has influenced their routine work activities. Roughly, 55% of participants indicated that COVID-19 had changed their daily activities. The social distancing policy has led to lower productivity and less meeting with customers. Also, the influence has been noticed in different other directions including, but not limited to, a decline in sales, delay in material delivery, workforce shortage, and higher cleaning and disinfection cost.

The North Carolina Locate Resolution Partnership Committee

The North Carolina Locate Resolution Partnership Committee (NC Resolution Committee) utilizes data analysis to improve the performance of NC 811. The members of the NC Resolution Committee include individuals from utility companies, excavators, locators, and NC 811 staff. The group convened in the summer of 2018 and the committee began creating a mission statement to guide the direction and establish the ground rules. The NC Resolution Committee utilizes data to propose actions which makes this effort unique and promising. Data often considered the raw material of knowledge which require evaluating to deliver meaningful recommendations and corrective actions. Therefore, the utilization of data to improve the resilience of damage prevention processes makes the NC Resolution Committee worth monitoring and assessing. When the NC Resolution Committee was originally discussed among stakeholders, the decision was made to create two separate NC Resolution Committees in North Carolina's two most populous counties: Wake County and Mecklenburg County. Each committee took independent ownership over their own work. For example, the NC Resolution Committee of Mecklenburg County decided to create a white lining video to assist excavators in understanding the importance of white lining and to provide guidance on the best ways to perform that activity to help locators better identify where excavations are to take place. After several months of having two NC Resolution Committees work independently, it was determined that it would be more effective to combine the two and expand the group to include people across the entire State of North Carolina.

At the beginning of 2019, the NC Resolution Committee members noted an increase in the number of update tickets based on the data provided by NC 811. Update tickets allow excavators to provide coverage and legal compliance for an excavation that is not completed within 15 working days. Although placing an update ticket is perfectly acceptable as part of the process, it

was discovered that roughly 30% of all tickets were updates of original requests.

Excessive updates hinder timely locates due to excessive amounts of work being requested either before the actual work takes place or after the work is concluded. It also adds considerable costs to utility owners, who must pay the expenses required for each locate. In addition, unnecessary updates increase the membership fees that must be paid to NC 811 by the utility owners. Accordingly, the NC Resolution Committee further investigated instances of updated tickets in which the work duration, as provided by the excavator, was one day or less. The investigation indicates that a considerable number of update tickets are updated twice or more. This means that an excavation task that could be completed in a single day has often been located at least three times over a 45-day period. As the NC Resolution Committee explored this further, they found that many of the excavators who were creating the excessive updates were working directly for the utility owners themselves. As a result, the identified utility owners have been notified to start monitoring their subcontractors to reduce system noise. The utility owners have been encouraged to initiate this effort to improve their overall financial performance as well. That is, the NC 811 membership fee for utility owners is based on their share of overall ticket volume, including update tickets. Furthermore, utility owners pay their locating contractors to mark the proposed excavation area after each request is placed through NC 811, which includes update tickets.

Highlighting the economic impact of such noise on utility owners is a critical steppingstone to optimize the management of the damage prevention process by utility owners. Utility owners should increase outreach and education funds to reduce system noise which will deliver an acceptable return on investment by reducing locate expenses and fees for one call center membership. Among the utility owners who responded to the NC Resolution Committee is Segra,

one of the largest independent fiber bandwidth companies in the US and a member of the NC Resolution Committee.

Accordingly, letters were sent to the excavators who contributed the most to system noise and the entities that contracted them in November 2019. The identification of the top 20 contributors was based on the number of tickets updated two or more times with a work duration of one day or less; that is, work that should take one day or less had not been completed within 45 working days of the original ticket. Table 8 shows the percentages of tickets that met this identification criteria. The letter points out the undesirable effects of system noise and the resulting costs to the utilities. The letters were purposely written to offer education to those firms by NC 811 and the NC Resolution Committee about the issue without proposing enforcement actions. As a result, several onsite meetings were conducted to clarify the processes, understand the challenges of the companies creating the tickets, and educate professionals about the impact of the tickets which, if not directly tied to work being conducted, could be considered in violation of NC law. Continued review of data during and after these onsite efforts demonstrated that they were effective in reducing the occurrence of update tickets over the short term. For example, the excavator with the fifth-highest occurrence in December (see Table 8) was provided with specific onsite training. This training was delivered by the utility that contracted the company and a representative of NC 811. The training stresses the costs of these and their influence on overall damage prevention efforts. When the report was run in January, the company was no longer in the top 20.

Table 3. The Percentages of Tickets of the Top 20 Excavators – December 2019

Firm Code	Concernment Update	Total Update	Concernment Tickets (%)
1	332	4,076	8.1%
2	326	2,822	11.6%
3	319	2,042	15.6%
4	216	4,927	4.4%
5	185	1,035	17.9%
6	184	271	67.9%
7	168	947	17.7%
8	98	586	16.7%
9	97	544	17.8%
10	94	189	49.7%
11	87	188	46.3%
12	76	306	24.8%
13	62	163	38.0%
14	58	259	22.4%
15	57	61	93.4%
16	50	204	24.5%
17	46	236	19.5%
18	43	265	16.2%
19	42	100	42.0%
20	39	104	37.5%

NC 811 – Educational Material Review

There is a shortage of skilled utility locators as well as excavators in the United States. Thus, there are new hires every day to fill the need, which requires good quality training to qualify them to efficiently do their duties and reduce thrid party damages. Accordingly, this part of the report reviews the current training materials that are available for locators and excavators in the state of North Carolina. The review goal is to identify potential improvement areas.

In 2011, utility owners, locators, and NC 811 partnered together to form Pipes Plus to educate the general public about safe digging practices around a multitude of utilities. In the beginning, the goal was simple, set up meetings across North Carolina and show a two-hour presentation that people from the utility industry could attend. The presentation consisted of topics covering what NC 811 is, how utilities are located, excavator safe digging practices, and information concerning digging around gas, electric and telecommunication lines.

An online training portal was created in 2014 so that those who could not attend a live meeting would be able to take advantage of the training from work or home. This online, video-based training uses the same videos from the live meetings. The trainee receives an emailed certificate of completion after taking a 70-question exam at the end of the presentation. The American Public Works Association (APWA) is a supporter of the Pipes Plus program as continuing education. Also, Pipes Plus is an excellent resource for companies across the state to have their employees trained on this material for free. A number of local technical schools have also been approached to incorporate the training into their curricula. The current training curriculam consists of the following sections:

- North Carolina 811 (8:06 min): This section covers information about who North Carolina

811 is, the importance of always notifying NC 811 in advance of your excavation, what you can expect from the process, electronic methods of requesting tickets and details about the damage reporting process.

- Excavation Best Practices (11:51min): This section covers the best practices the could be followed to prevent third party damages such as site visits prior to excavating, white lining, and notify NC 811 when a damage occurs.
- Utility Locating (8:31): This section covers the safety of locators, excavators, and cmmunity, locates' quality in terms of markings, and locates' timelineess.
- Natural Gas Distribution (11:17): This covers products include Natural Gas, Propane, Jet Fuel, Gasoline, and Diesel fuel that distributed through intrastate and interstate pipelines.
- Natural Gas Transmission (6:16): This covers gas transmission lines. There are several distinct characteristics between Transmission and Distribution Pipelines. Transmission pipelines are used to transport products to the distribution pipelines, storage facilities, terminals or end users. Transmission pipelines are larger diameter pipes with higher pressures and larger volumes.
- Electric (8:16): This covers electricity.
- Telecommunications (6:00): This covers digging in and around telecommunication facilities.
- Water and Sewer (4:47): This covers digging in and around water and sewer facilities.

In general, these sections target excavators. However, the recent studies have been carried by NC 811 indicate the need for the following (Al-Bayati and Panzer 2019; Al-Bayati and Panzer 2020):

- **Excavators Awareness Training** which should cover:
    - **NC 811 Locate Ticket Type**: Information about the process of damage prevention,

the types of tickets that excavators can utilize, the consequences of placing incorrect or false tickets, and the limitation of the current process (e.g., coupling effect, abandon lines, broken tracers, and weather impact).

- **Site Representative and White Lining**: The importance of clear communication (e.g., contractor representative and white lining) with locators and the one-call center should be the core of awareness and educational efforts.
- **Site Visit**: Excavators should visit the site before placing the ticket to ensure that the site is accessible as well as to white line the excavation area.
- **Tracer Wires:** Locators have indicate that broken tracers contribute significantly to inaccurate locates, many excavators seem not to be aware of the tracer wires. Thus, it is expected that they will not report the damaged tracers, even though there are typically no financial penalties for breaking a tracer. Therefore, the educational material should clearly explain the importance of reporting damages to tracer wires.
- **Positive Response**: Visual inspection was reported as one of the methods to verify that all notified utilities within the proposed excavation area have been marked. In addition to being a violation of the law, this method is not efficient because it does not ensure that all utilities have been marked.
- **Damage Reporting:** Reporting the damages lies with the employer (i.e., the contractor). The damages must be reported to NC 811 as required by North Carolina General Statutes (87-126).
- **Notifying NC 811:** Emphasizing excavators' responsibility to notify the one-call center or verify that general contractors or landowners have already notified the one-call center to reduce notification error;

- **Locating Equipment**: The influence of limitations of locating equipment and site conditions (e.g., incomplete or out-of-date blueprints and abandoned utilities) on overall locating accuracy;
- **Small Projects:** A plan identifying who should notify the one call center must be created and communicated so that the responsible party notifies the one-call center. This is needed to manage the relationship between homeowners and excavators properly. However, it should be realized that utility owners will not locate homeowners' and landowners' private facilities. Thus, excavators should rely on the homeowner/landowner or a private locator, and if they are in error, it is not the excavator's fault.
- **Utility Agreement Plan**: A utility agreement plan between construction firms and utility owners should be utilized for large projects. The agreement between construction firms and utility owners supersedes the state prevention act. As a result, it benefits construction firms that have projects across the United States to have a unified management method for addressing existing underground utilities.
- **Temporary Nature of the Marks**: Best practices to sustain the locating marks against weather and work conditions; and the importance of photographic documentation of the job sites before, during, and after excavation.

- **Locators Awareness Training** which should cover:
  - **Positive Response Codes:** Information about the process of damage prevention, the meaning of the codes used for positive responses, the consequences of incorrect positive responses, the limitation of the current process, and how to reduce its impact.
  - **Clear Communication:** The importance of clear communication with field

personnel and utility owners. For example, the study revealed that inaccurate maps negatively impact the accuracy of locates. Thus, it is crucial to open a communication channel between locators and utility owners to report inaccurate maps in order to update them.

Also, both excavators and locators should receive information about the following:

- The shared responsibility means all involved parties have obligations to damage prevention. As a result, prevention acts should establish a shared responsibility approach to encourage all parties to improve their performance.
- The System Noise Reduction
- Legal Affairs and Dispute Resolution of Damages

Finally, each training section must start with the section goal and section objectives.

Section Goal: is a general statement describes how training will solve the identified training's need and conmnicate the purpose of the training solution and articulate specific outcomes that should be achieved through training.

Section Objectives: statements that clearly describe what learners will be able to do as a result of completing the section. Objectives differ from goals in that they are measurable abd observable.

References

Al-Bayati, A. J., and Panzer, L. (2019a) "Requirements and Practices of Underground Construction Activities: A Review of Recently Updated Act." *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 11 (3), DOI:10.1061/(ASCE)LA.1943-4170.0000300

Al-Bayati, A. J., Panzer, L., and Karakhan. A. (2019) "Reducing Damages to Underground Infrastructure: Performance Evaluation of One-call Notification Program." Practice Periodical on Structural Design and Construction, 24 (4), DOI:10.1061/(ASCE)SC.1943-5576.0000441

Al-Bayati, A. J., and Panzer, L. (2019b) "Reducing Damages to Underground Utilities: Lessons Learned from Damage Data and Excavators in North Carolina." *Journal of Construction Engineering and Management*, 145 (12), DOI:10.1061/(ASCE)CO.1943-7862.0001724

CGA, Common Ground Alliance, (2019). "Best Practices Guide" <https://commongroundalliance.com/programs/best-practices (August 12, 2019)

DIRT (2018). "Damage Information Reporting Tool" <http://commongroundalliance.com/dirt-dashboard> (11/18/2018)

Farnsworth, C. B., Warr, R. O., Weidman, J. E., and Hutchings, D. M. (2016). "Effects of CM/GC Project Delivery on Managing Process Risk in Transportation Construction." *Journal of Construction Engineering and Management*, 142(3), 04015091.

Goodrum, P., Smith, A., Slaughter, B., and Kari, F. (2008). "Case Study and Statistical Analysis of Utility Conflicts on Construction Roadway Projects and Best Practices in Their

Avoidance." *Journal of Urban Planning and Development*, 134(2), 63-70

Hyari, K., and El-Rayes, K. (2006). "Optimal Planning and Scheduling for Repetitive Construction Projects." *Journal of Management in Engineering*, 22(1), 11-19. doi:10.1061/(ASCE)0742-597x(2006)22:1(11)

Li, S., Cai, H., and Kamat, V. R. (2015) "Uncertainty-aware geospatial system for mapping and visualizing underground utilities." Automation in Construction, 53, 105-119

Mahalingam, A., and Levitt R. E. (2007). "Safety Issues on Global Projects." *Journal of Construction Engineering and Management*,133 (7): 506-516. Doi:10.1061/(ASCE)0733-9364(2007)133:7(506)

Metje, N., Ahmad, B., and Crossland, S.M., (2015). "Causes, impacts and costs of strikes on buried utility assets' Institution of Civil Engineers." Proceedings. Municipal Engineer, vol. 168, no. 3, pp. 165-174. DOI:10.1680/muen.14.00035

Quiroga, C., & Anspach, J. (2016). "Managing Utilities in 3D Design and Construction Workflow." *Proc. Pipelines,* Kansas City, Missouri. DOI:10.1061/9780784479957.084

Talmaki, S., Kamat, V.R., Cai, H., (2013) "geometric modeling of geospatial data for visualization-assisted excavation." *Adv. Eng. Inform,* 27 (2) (2013) 283–298. https://doi.org/10.1016/j.aei.2013.01.004