

THE TRAFFIC COUNTING MANUAL

AN INSIDER'S GUIDE TO:
**Organizing, Collecting,
Processing, & Pricing Traffic
Data Collection Projects**

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During my second week on the job as a newly minted traffic engineer in 1996, my boss gave me a box of tube counting gear and a product manual. He told me to read the manual and then install the counting gear on a frontage road project. Welcome to traffic counting!

Five years later I was working for the city of Maple Grove, dreaming of being a business owner when I saw a niche — while there were traffic counting companies around the country, none existed in Minnesota.

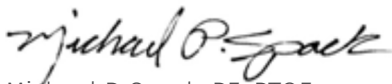
I was involved with my ITE section at the time and started talking to friends and colleagues from other agencies and consulting firms about them outsourcing their traffic counts. A few of them thought it was a great idea and said they would give me a shot at doing their traffic counts as a subcontractor. So, in 2001 I started Traffic Data Inc.

20,000+ counts later, Traffic Data Inc. is still going strong, and we've branched into a transportation engineering consulting firm, Spack Consulting, as well as a counting equipment manufacturer, SpackSolutions.com.

Since 1996, I've learned a lot about counting cars (and heavy vehicles, bicycles, pedestrians, trains, and even boats!), mostly through trial and error, but also from chatting with other data collection folks around the country.

In this manual, I show you how we do data collection here at Traffic Data Inc., from bidding jobs, to organizing field personnel, to collecting accurate data cost-effectively. The Traffic Counting Manual is not an academic treatise...it's just solid, proven advice – a manual by data collectors for data collectors.

I hope you find it useful!

A handwritten signature in black ink that reads "Michael P. Spack". The signature is written in a cursive, flowing style.

Michael P. Spack, PE, PTOE

P.S. We launched Version 1.0 of this Manual in 2012 and Version 2.0 in 2015. There are several thousand copies of the Manual in circulation, and I've proudly permitted professors at more than ten universities to use it in their traffic engineering curriculum. This update includes recent developments in the industry and incorporates great feedback we received on the earlier versions. I'd love to get your feedback on Version 3.0. Send me an email at mspack@spacksolutions.com.

P.S.S. I've been blogging about traffic data collection and transportation engineering at MikeOnTraffic.com since 2006. Please visit and subscribe for tips, advice, and the latest industry trends.

INTRODUCTION

There are lots of ways to collect traffic data, but all of them follow the same basic pattern. To keep things simple, we've organized this manual into sections dealing with these basic procedures.

It's not a manual for any specific brand of hardware, but we do cover different methods and hardware you can use to collect the same type of traffic data.

Here are the specific topics covered in this Manual:

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TYPES OF DATA COLLECTION

There are many types of traffic data collection; but broadly speaking, traffic counts come in two categories – **road segment data** and **intersection data**.



Road segment data usually consists of collecting vehicle volumes, speeds, and classifications. Collecting this data is typically done automatically for several days with pneumatic tube counters or radar detectors.

Intersection data usually consists of turning movements and vehicle classifications, as well as pedestrian and bicycle movements. Traditionally, this was done for a few hours during peak periods by a person sitting at the intersection and logging the data on paper or with an electronic tally board.

Although the process of collecting the data will differ for these studies, the general practices found in this Manual apply to every type of traffic data collection.

Today, portable camera technology allows technicians to set up hardware in minutes and collect video to be counted back at the office or outsourced to a vehicle counting company.

In addition to segment and intersection vehicle counts, there are much less common types of short-term traffic data studies, including license plate matching origin-destination, saturation flow, queuing studies, delay studies, train crossing studies, pedestrian compliance studies and more.

Electronic tally boards and computerized pneumatic traffic counters revolutionized traffic data collection in the 1970s. A fun piece of trivia is Bill Gates developed a pneumatic tube counter before founding Microsoft. It took about forty years, but portable video camera technology and artificial intelligence are again revolutionizing traffic data collection.

Instead of collecting 48-hour roadway segment data and two hours of peak period intersection turning movement count data, agencies and consultants around the world are cost-effectively merging the two and collecting 48-hour turning movement count data with video.

The benefits of 48-hour intersection turning movement counts include:

01

Increasing safety for personnel by eliminating the need for staff to enter the traffic stream to install tubes on the road.

02

Improving the level of service calculations based on averaging peak hour data, as well as identifying anomalies.

03

Collecting multi-modal transportation data.

04

Providing data for accurate traffic control warrant analyses and traffic signal timing.

05

Increasing field work efficiency by easily working around bad weather and street sweeping, the enemies of pneumatic tubes.

06

Eliminating the liability of bicyclists thrown off by a tube, a pedestrian tripping on a tube, or a nail letting loose and puncturing a tire.

We have transformed the breadth and quality of the transportation engineering consulting we do at Spack Consulting because of the rich data we collect now with video camera technology.

Full disclosure – I started SpackSolutions.com to design and sell the hardware/software I wished we had. I'm proud of the video camera hardware and cloud-based tube counter ecosystem we've designed specifically for the traffic data collection industry as well as the video processing services we provide through SpackSolutions.com.



**COUNTING
CARS.COM**

We make affordable, reliable hardware for
efficient and easy traffic data collection





STEP 1

LOCATION & TIME SELECTION

No matter what type of traffic data you're collecting, the first step in the process is determining why you need traffic data. Based on the answer, it's usually straightforward to determine how you'll collect the data along with the location/duration of the count. The engineer in charge usually gives these details to the contractor, engineer in training, or technician. But the person doing the data collection may know a better way (cheaper/faster/more accurate) to meet the data needs of the engineer requesting the data.

A good example of this was a call we received from a public works employee asking for a bunch of 48-hour tube counts, including vehicle classification data. He was doing this to get a handle on the traffic patterns downtown.

After chatting for a few minutes, we determined we could get more accurate data in the slow-moving downtown with 48-hour turning movements at a couple of key intersections. He didn't know about the video technology that made 48-hour turning movement counts feasible.

We counted heavy vehicles, passenger cars, pedestrians, and bicycles all separately. This way of collecting the traffic data ended up being more informative and cheaper than the original request.

After you've pinned down the scope of the data collection, it's important to check with the proper authorities (city, county, or state public works) to ensure there's no scheduled road construction in or around where you'll be collecting data.

Also, if you are doing tube counts, be sure to check on street sweeping schedules with public works — street sweepers will shred pneumatic tubes and may even damage the counters. And it's also important to pay attention to weather forecasts — snow plows also destroy tubes.

Additionally, counting during severe weather won't produce traffic data from average conditions, which is what traffic engineers typically want. Using video cameras for your data collection alleviates many of these concerns.

NOTE: In addition to contacting public works, be sure to contact the local police department if you're going to have folks sitting on the side of the road doing manual turning movement counts.

During my first year on the job, I had a jolting run-in with the police. At 6:30 in the morning, I parked in a bank parking lot and was waiting in my car to start a turning movement count with an electronic tally board. Three squad cars converged on my car, sirens blaring, and the adrenaline rush woke me up faster than any coffee could. One of the officers slowly got out of his squad and carefully walked up to my car with his hand on his holstered gun.

Thankfully, he was a sergeant who happened to know me from a meeting at city hall the week before. Things were easily

cleared up, but I could have avoided the whole situation by letting the city know I'd be out there doing the count.

I certainly remembered this experience five years later when I started Traffic Data Inc. I had "Traffic Count in Progress" magnetic signs made for all the data collection staff to put on the outside of their cars. I also set up a policy of calling the local public works and police departments in advance of fieldwork. I recommend you do both to avoid issues on your traffic counting projects.

Also, avoid setting up traffic counting hardware in the field during heavy traffic conditions. You could make congestion worse, and you'll also be less safe on/by the road during rush hour. It's best practice to avoid installing pneumatic tube counters during the morning and evening peak periods.

NOTE: Mid-morning is the best time to work on corridors with heavier traffic.

Sometimes, data collection companies even work in the middle of the night when installing gear on freeways. If you have a safe place to park your work vehicle, you can set up video cameras or radar detectors during rush hour because you don't step on the road to install them.

After the where/when of the data collection project has been determined, you should notify the local police there will either be people sitting next to intersections for long periods of time or equipment sitting on the side of the road. Shortly after 9/11 part of downtown Boston was shut down by the bomb squad.

Why? A tube counter looked like a roadside bomb.

We have stickers made showing Traffic Data Inc, with our logo and phone number on them that we affix to each piece of traffic counting gear we install. These stickers on our hardware have helped us on several occasions.

For example, one evening around 8 pm, a sheriff patrolling the Federal Reserve building in Minneapolis called us about a camera system he saw near the corner of the building, attached to a street sign.

Thankfully, I answered the forwarded call and quickly assured him the system was legitimate. We were working for the City of Minneapolis, who we notified of our work, but the message didn't get passed on to the Federal Reserve.

I recommend having your company/agency name and phone number on all your hardware, even if you write them on the gear with a sharpie marker. You don't want to be on the news because of a bomb scare!

An additional benefit is that we occasionally get calls from neighbors about our hardware too. I believe those calls help avoid vandalism and also keep the cities we work in happy because they don't get the calls.

If you want to get sophisticated, you can develop a QR sticker for your gear that sends people to a web page explaining what the gear is doing and who you are (hat tip to Traffic Data & Analysis out of Wisconsin, for that one).



STEP 2

PRE-INSTALLATION PREPARATION

Before the actual data collection, it's important to prepare as much as possible while still in the office so everything will flow smoothly out in the field. Sometimes it may seem as though the data collection process is quite simple, but going out into the field without proper preparation can, and many times does, lead to problems. It's easy to get caught up in the moment and miss an important step (especially if you're working in bad weather).

Early on in Traffic Data Inc's history, while I was still employed by the City of Maple Grove and doing counts as a side business, I drove out after dinner to install a couple of tube counters about 45 minutes from my house. When I got there, I realized I had forgotten to put the tube counters in with the bin of tubes and tools! My wife (along with my 8-month old daughter in her car seat) drove out to bring me the counters after a panicked phone call.

The use of checklists has made airline flight the safest mode of transportation. A quick checklist would have saved my wife an evening in the car (as well as my working at dusk).

Check out the Checklist Manifesto by Dr. Atul Gawande about how checklists are greatly improving healthcare if you're skeptical about the power of checklists. The punchline is you should use checklists.

ORGANIZING STAFF

Once you've determined the type of data collection you need to do, along with the location and schedule, you'll need to coordinate the people collecting the data. If you need multiple people to complete the data collection, the first task is to determine how many people you need for the project. Then, you need to get them scheduled.

AUTOMATIC COUNTS

(TUBE COUNTERS, RADAR COUNTERS,
MACHINE VISION)

For automatic counts, only one or two people will be needed to set up and take down equipment. Only one person is needed to set up a counter on a low traffic road (less than 1,000 cars a day). If the road has more than 10,000 vehicles per day, two people should be sent out for safety reasons – one experienced person to do the set up with one inexperienced person to watch their back.

For roads with 1,000 to 10,000 vehicles per day, one vs. two people teams are a judgment call based on the experience of the people, the width of the road, and the time of day the counter will be set out. Safety always comes first. When in doubt, send out two people.

We recommend saving the data on each counter after the count is complete. Then we like to clear the data in the counter before its next use. Too much data in the counter's memory slows the data download.

Clocks should also be synchronized at this point to make sure all the clocks are accurate. The clocks drift over time in electronics, plus it's easy to forget to adjust the clocks after Daylight Savings Time.



This procedure is best practice if you have older model tube counters, but we removed these steps with our wayCount tube counter which uploads its data from a phone app to the cloud-based system and always has an accurate clock and GPS based location. Our wayCount tube counter saves a lot of time by streamlining setup and eliminating downloading in the office.

Ideally, the person doing the data collection will have experience with the hardware you have. If they don't, plan on the project taking a little more time. Also, make sure they have the appropriate manuals and a phone number for the manufacturer's technical support. If the manufacturer has how-to videos online (like SpackSolutions.com), make sure the data collection team watches the installation videos ahead of time. It's also important the data collection crew knows the scope of the project they're working on so they can make a judgment call if an issue arises in the field.

They should understand the priority of their work in case they won't be able to complete it all. Give them explicit instructions to call the engineer in charge if they see signs for a concert, festival, road closures, etc. Clients and bosses appreciate knowing about these situations and may choose to delay or expedite the data collection based on the situation.

Early on in Traffic Data Inc's existence, we were scouting for a project we were scheduled to set up a couple of weeks later. We happened to be in the area for a different project. Our technician noticed signs saying the nearby interchange was going to be closed in two weeks when we were scheduled to conduct the counts.

We let the client know immediately, and we ended up doing the project the next day instead of waiting, since the interchange closure was going to affect the local traffic patterns. The engineers involved in the project were very appreciative and have been loyal clients ever since.

VIDEO RECORDING

In order to set up video recordings to be manually counted in the office, one person needs to set up the recorders, and then appropriate people will need to be organized to count in the office. You can consider a second person on the setup crew if you have more than ten cameras to install in a close area.



Otherwise, the efficiency gained by adding a second set of hands is offset by the downtime driving between sites. A second person isn't needed for safety reasons since you don't have to enter the roadway to set up cameras the way you do to install tube counters.

Procedurally, setting up video camera systems is like setting up tube counters. You're just going vertical with your gear instead of horizontal. Once you have the videos, there are a couple of options for extracting the data. The video can be sent out to a service (such as **COUNTcloud**) to have the count data extracted, or you can watch the videos in your office and extract the data yourself.

If you're going to process the video yourself, we recommend using the COUNTpad/COUNTpro system which allows you to watch the video at a variable speed as well as pause the video to take breaks.

Unless the schedule is extremely tight, video data collection will provide more flexibility than manual counts. It's important to assess how much video will need to be processed and approximately how quickly the data processing crew will be able to process the video. The hardware/software manufacturer can help you estimate how many people a project will take, as well as how to best process the data.

If you want to know more about video recording and data processing, feel free to contact us by going to **SpackSolutions.com** and scheduling a free 30-minute consult where we can talk about your project and its needs.

MANUAL COUNTS

The most important part of a manual count is lining up reliable staff to do the count in the field; and quite honestly, it's easiest to schedule and train full-time staff to do so. If you're using staff from a temp agency — which is how we started at Traffic Data Inc — coordination should start about a week ahead of the data collection date.

In either case, it's best to give at least a few days' notice to the people who will be out in the field and to go through your procedure.



People at the intersection doing the count with an electronic tally board can get overwhelmed when traffic at the intersection gets busy. **The general rules we use are:**

- One person can count up to 2,500 vehicles an hour.
- Two people will be needed if estimates show there will be more cars than this or there are free right turn lanes.

PEAK HOUR VOLUME

You'll need daily traffic volume data to estimate if the peak hour volume is over 2,500 vehicles (commonly called ADT or AADT – Average Daily Traffic or Annual Average Daily Traffic).

This data should be available on the state, county, and city websites for busier intersections that may have over 2,500 vehicles entering in the peak hour. To estimate the peak hour entering volume from daily volumes, add the daily volume on the busiest leg of the major street to the daily volume on the busiest leg of the minor street.

Then, divide the sum by ten, and you have a reasonable estimate of the peak hour volume. Also, you'll need two people doing the count if the intersection has free rights turns. One person can't accurately count a whole intersection while continuously keeping track of a free right turn lane.

NOTE: When I started my career, I was assigned to do a count by myself at an intersection from 6 am to 10 pm. Welcome to consulting! The supervising engineer came out and gave me a one-hour break over lunch. It was horrible. I believe staff in the field shouldn't count any longer than three hours without a break.

PLANNING THE DAY

It's important to make sure your staff understands the project and their specific roles. Provide every data collector with a map of the project area, and the time the collection will take place. I recommend someone well versed in the project meet with the data collectors in the field before the data collection begins.

Meeting early will give the data collectors a chance to ask questions and to make sure everyone is on the same page. At this meeting, hand out the electronic tally boards (or clipboards with a matrix to write in, which is the very antiquated way of doing turning movement counts and not recommended).

Our experience at Traffic Data Inc is it's best to meet at a gas station or fast food restaurant (with public restrooms) within the study area about half an hour before the count is scheduled to start.

You should have all the electronic tally boards programmed and turned on at least half an hour before the counts are scheduled to start. Handing out the boards and answering questions should take about five minutes. Then give everyone five to ten minutes for a quick trip to the restroom (for obvious reasons). Then five to ten minutes for the data collectors to drive out to their intersections and get situated.

We also like to meet back at the gas station or restaurant when the counts are done to gather the equipment and discuss any observations the data collectors may have made while out in the field.

Counting in the field is taxing. Please be kind to your staff.

Keep this meeting brief so they can get home. If you only do one or two counts per year, look into TrafData's turn count app. The plus side is it's cheap, but the downside is you have to watch your screen to make sure you're counting accurately.

Tactile buttons on an electronic tally board, such as the micro tally from Vehicle Counts, make it possible to count busier intersections as the counting becomes more like typing where you're not looking at your fingers.

The complexity, inefficiency and potential inaccuracy of using electronic tally boards in the field led us to develop the **COUNTcam system**. If you do more than a couple turning movement counts per year, I strongly recommend you investigate video camera technology as it will likely save you money in addition to making your life easier.

It's important to make sure your staff understands the project and their specific roles.

ORGANIZING EQUIPMENT

Every type of traffic data collection requires some equipment. It's crucial to have enough functioning gear before going out into the field. Failing to pack enough working equipment can lead to a failure in the data collection process.

Make sure your equipment is charged up and functioning properly before leaving the office. It's simple to pack enough working equipment, but it amazes us how many panicked calls our tech support at SpackSolutions.com receives from folks on the side of the road with non-functioning equipment (very often dead batteries).



Hardware needs to be routinely tested to make sure it's working. To minimize vandalism or the police removing your equipment, we recommend you put your company phone number and website on your hardware.

It's better to receive a slightly annoying call outside of business hours than to show up to pick up the gear at the end of the count and find the hardware missing.

AUTOMATIC COUNTS

(TUBE COUNTERS, RADAR COUNTER,
MACHINE VISION)

Of all the automatic counters out there, tube counters are by far the most used. Installation is relatively easy, and one person can usually handle the installation, although two people make installation faster and safer.

Here is our recommended checklist for doing an automatic tube count:



Prepare. Plan ahead what kind of tubes to use.

Thicker tubes work well on unpaved gravel roads. Thinner tubes are a lot easier to work with and get the job done on smooth pavements. Also, make sure the tubes are the right length to span the road, without being unreasonably long. We discourage the use of any tube over 60 feet because the air pulses may not be strong enough to register in the counter. 50-foot-long tubes are the industry standard. Also, it's important the tubes are the same length on a two-tube installation. The data algorithms are thrown off by the air pulses resulting from different length tubes. Note, tubes less than 35 feet long can result in strong air pulses which might damage the sensors.



Test the Equipment. Vehicle Counts sells tube simulators you can use to make sure your tube counters are performing correctly. We recommend testing all your tube counters at least annually. And of course, it's easy to test a drill by pulling the trigger.



Charge the Batteries. Be sure to fully charge the counters ahead of time if they're rechargeable or check battery levels and replace low batteries if they're not rechargeable. Also, drills and any other battery powered tools should be checked and charged.

There's nothing worse than getting to the job site and having to improvise because of a dead battery. After dealing with this problem more than a few times, we bring multiple batteries, a charger, and an inverter in the work vehicle, just in case. Still, a dead battery takes time to charge, which adds time to the project.



Label. Make sure each tube counter is distinguishable from one another. You can do this by simply writing a number on the side with a sharpie marker. Hardware typically comes with a serial number, but this may be too cumbersome to use as a way of tracking counters. We choose to use the serial numbers on the devices. You could choose to use the last five digits of the serial number too.



Accessorize. Always bring extra tubes, and possibly tubes of different lengths and thicknesses, just in case. Almost any tube count will require the use of the following: pavement nails, concrete pins, spikes, nylon straps, tape, rope loops/mounting clamps, locks, chains/cables, drills, hammers, and a crowbar. Not having or running out of any of these things can slow down the installation process and affect the overall data collection.



Extras. When possible, bring a reasonable amount of extra gear. We recommend bringing about 20% more counters than needed. Sometimes batteries inside some brands of counters inexplicably die, or the counter gets banged around and doesn't seem to work right in the field. It's nice to quickly move to a different counter instead of trying to troubleshoot while in the field. A situation may also arise where you planned to use one counter, but the median is too wide, and you need to install two.

For radar counters and machine vision counters, first make sure there are enough of each counter, and you have the proper accessories. Again, make sure all battery powered equipment is charged up.

Keep in mind some equipment — such as machine vision counters — are rather large and may require the proper means to transport them to the project site.

A dedicated van with built-ins for the necessary gear is ideal, but most of us end up working out of a makeshift survey vehicle, or even a personal vehicle at some point. In 2018 we switched to a Chevy Volt to save on fuel costs, which is possible because counting gear keeps shrinking. Working to keep equipment organized in toolboxes and bins is a great way to make the life of a data collector much easier.



VIDEO RECORDING WITH MANUAL COUNTING IN THE OFFICE

If you're setting up video equipment to record turning movement counts, be sure there are enough recorders, cameras and other accessories for each intersection you need to study.

Depending on the system you're using, these accessories could include SD cards (with adequate storage capacity), extra video cables, mounting belts or poles for the camera, Velcro straps to secure cords, a portable TV monitor, mobile phones with apps, remotes, drills, hose clamps, bungee cords, locks, cables, and chains. You might also want to use a ladder if the cameras need to go on posts or trees.

Several companies, including **SpackSolutions.com**, sell complete camera count equipment sets containing everything needed to do a video count, minus the ladder and truck of course.

MANUAL COUNTS

We developed modern video camera tools to do turning movement counts because we were tired of doing manual counts at 6 in the morning. But if you only do one or two turning movement counts a year, there are several ways to do manual turning movement counts in the field.

You can do manual counts with a pen, paper and a stopwatch (how Mike started his career), an electronic count tally board (how Max started his career), a laptop computer with counting software, or a smart-phone or tablet computer with a counting application.

If you're doing a low volume count with pen and paper, make sure there's enough of each, as well as enough functioning watches or stopwatches to break up the intervals. Doing counts with pen/paper is rare now, but in the old days, we'd make a grid where movements were in the columns and time intervals were in rows. Then we'd fill in the matrix in the field with hash marks (we also had to call our friends on the phone with a cord to make plans for the weekend). If you're going to do one or two low volume counts, we recommend you invest in an app such as

Trafdata's Turn Count.

WARNING: *in our experience, we found it difficult to accurately count busy intersections from the side of the road with an app or paper.*

ORGANIZING PAPERWORK

It's important to provide clear instructions for staff and have clear records of what you did on every data collection project.

Preparing ahead of time in the office can prevent confusion and mistakes in the field, as well as provide documentation of what the field technician did if questions arise about the data.



Start by coming up with a numbering convention, so every count project has a unique site code. Of course, this site code system can start at 1, but we use a more involved scheme to make finding data easier.

OUR SYSTEM:

The first three digits represent the client (every client is assigned a unique client number), the second two digits are the year, the next two digits identify the project, and the last three digits represent the specific intersection or automatic counter location.

This schema provides a unique number for every count we do and helps us easily find files. This numbering system also gives a sense of what the files are without opening them.

However, if you're only doing a few dozen counts a year, then this scheme is overly complicated. It's important to develop a numbering system and then use it every time.

AUTOMATIC COUNTS

(TUBE COUNTERS, RADAR COUNTERS,
MACHINE VISION)

When doing tube counts, we recommend you prepare a sheet for each location where you'll install a counter.

This sheet should include:

- A unique site code (entered in the office)
- An aerial image of the location (entered in the office)
- The location description (entered in the office)
- The hardware serial number (entered in the field)
- The configuration of the tubes or the device direction (entered in the field)
- Install date and time (entered in the field)
- Removal date and time (entered in the field)
- A hand sketch on the aerial of the hardware orientation (entered in the field)

Having the hand sketch of the hardware, and tube configuration if it's a tube count, gives backup information in case the person picking up the counter is different than the person who set it up. We like having the start/stop time written on the paperwork.

If the paperwork was screwed up or a file mislabeled, this is redundant information you can use to sort out the files by cross-referencing the times with the dataset. Radar and machine vision setups require similar paperwork documenting when and where the equipment was set up and taken down, the orientation of the equipment in the field, and equipment identification information.

Along with these individual sheets, a large map of the area with markings denoting each setup location can be useful to have, especially when more than a few counters are to be set up around an area. Or you can choose to create an aerial map with pins in a phone app your field techs can use.

At the moment, we prefer using paper to make sure the forms are filled out, and we're not dependent on an internet connection. We will likely change to a completely electronic system in the future. Check MikeOnTraffic to see if this book is outdated and we have an electronic system for you to use (or contact us at **SpackSolutions.com**).

VIDEO RECORDING WITH MANUAL COUNTING IN OFFICE

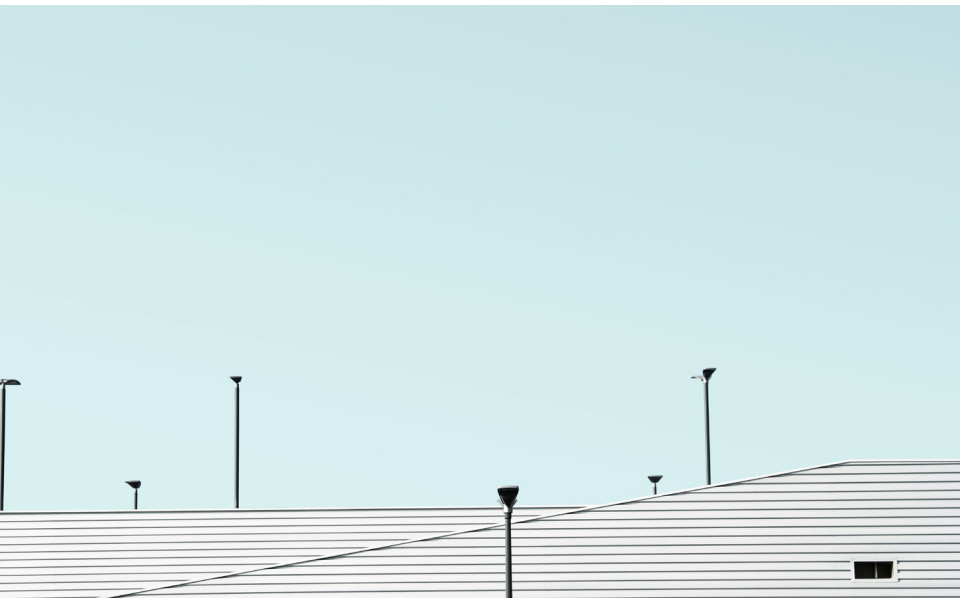
Once again, we recommend you create an individual sheet for each intersection you're counting. These sheets are the same as the above tube count sheets with two possible changes:

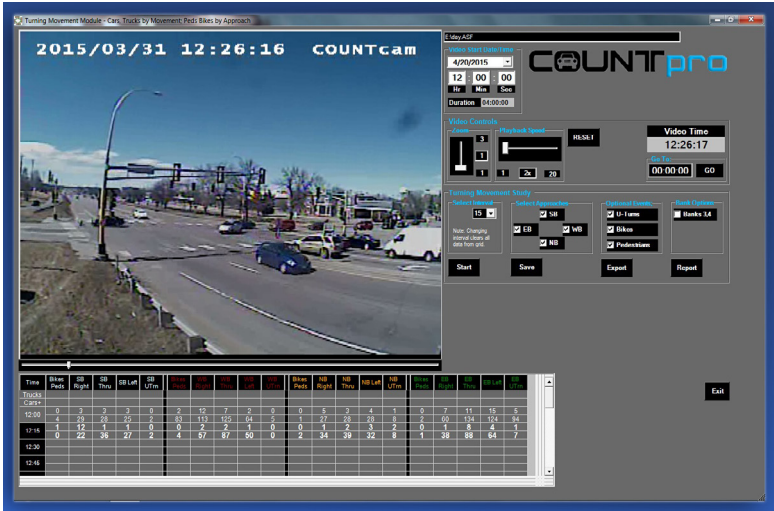
01

SD card number if you're swapping cards between cameras.

02

The field tech draws a symbol for the camera on the aerial with the direction the camera is facing.





Once the video recording is complete, the video will need to be downloaded and checked. Screenshots of the video should be made to indicate direction and street locations. These screenshots should then be put on a sheet to keep track of the video counting process.

This sheet should include the screenshot, site code information, location information, information about where the video is stored (on a certain computer or hard drive) and an area to mark off the time periods your team needs to count.

We offer free Video Joiner/Uploader software, available at SpackSolutions.com, which takes care of all these details for you.

MANUAL COUNTS

For manual counts, we also recommend having a data sheet for each intersection you're counting. These data sheets should include a sketch of the intersection with all the appropriate turning movements shown. The layout of the data sheet used will depend on the data collection method. These sheets should include the site code information, date and time information, location, the name of the person doing the count, and a serial number for the hardware used.

We also recommended including some instructions on the datasheet to inform the data collector conducting the count of any important steps in the process. Of course, detailed maps and instructions should be provided to the data collectors ahead of time.

If two people are counting at one intersection with manual count boards, putting masking tape over the buttons they're not using helps ensure each person counts their half of the intersection. Make sure the boards and paperwork line up with North or have instructions on how to do so.

STEP 3

HARDWARE INSTALLATION

SAFETY

Whenever doing any field work, safety comes first. Someone's life is always more important than any traffic count. Be sure to follow local OSHA and DOT requirements and always stay aware of danger while working in the field.

We recommend doing the following;

- Wearing reflective vests (full reflective pants/shirts if working at night)
- Utilizing traffic cones to delineate a work area if you're setting up tubes
- Using flashing lights on the work vehicle
- Using two people to setup tube counters on busier roads
- Parking the work vehicle off the road if you're setting up video cameras
- Avoiding working on the street during peak traffic times
- Avoiding unnecessary risks (e.g., standing in the middle of the road waiting for vehicles to pass)



Making sure data collectors are visible to motorists is very important. Avoid areas where drivers or the data collector don't have enough time to react to one another, such as around sharp curves, or places where visibility is an issue.

If road tubes are being laid down on a busy road, make sure the installers take the necessary time to be safe. While it may be redundant, make sure every data collector follows the rule we give our children before crossing the road: Stop, look left, look right, look left again, then if all is clear, start moving your feet.

Please, don't take any unnecessary risks. Assume drivers are texting, changing the radio, yelling at the kids and drinking coffee — all at the same time. Never assume they see you.

Unfortunately, safety extends to more than just avoiding distracted or drunk drivers. Hailey in our office was setting up cameras in a quiet industrial area, and a trucker pulled up in a semi-truck, parked, yelled out the window telling her she was cute, and then watched her finish the setup.

She told us about the encounter when she got back to the office. We now tell all our staff to abandon a count immediately if they feel any sense of danger. Losing some equipment is nothing in comparison to something bad happening to any of our co-workers.

A more lighthearted story - Hailey was setting up a camera in a neighborhood when a rafter of turkeys started coming at her (I didn't know a group of turkeys is called a rafter before fact-checking this). Several turkeys chased her into the work vehicle. It sounds funny, but she was scared in this situation too. Talk through these types of situations with your staff and be crystal clear personal safety always comes first.

Lastly, ticks in our region carry Lyme disease. We keep bug spray (and sunscreen) in our work vehicles to keep our staff protected. Think through what may be needed in your region to keep your staff safe and healthy.



DOING THE COUNTS

AUTOMATIC COUNTS: TUBE COUNTERS, RADAR COUNTERS, MACHINE VISION)

When using automatic counters, set up should be done in advance of when the data recording period is to start. Setting the hardware early ensures there's enough time to get all the equipment installed plus extra time just in case there are any equipment issues needing troubleshooting.

Often, installation can be done the day before data collection is to begin which often means installing on a Monday (normal weekday conditions are on Tuesday through Thursday in most regions).



However, tubes can break over time, so you may want to consider setting tube counters on Tuesday morning on critical projects to ensure you're collecting usable data immediately.

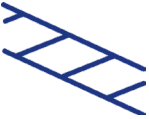
For items such as tube and radar counters, find a place next to the road on a straight segment where there will be little chance of vehicles stopping.

If, for example, you place a tube counter too close to a driveway, it's possible vehicles may queue past that point on the road and even stop on the tube. Slow moving and stopped traffic will lead to inaccurate data and may cause the study to fail.

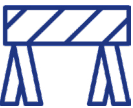
It's good to keep in mind tube counters work best when traffic is rolling over the tubes in a straight line and traveling at least ten miles per hour.

More than any other kinds of traffic data collection, the way tube counters are installed depends on the road type and weather. Here are a few of those factors and what they mean for a tube counter installation:

Initial anchoring of the tube to either side of the road:



Concrete curbs — Drilling into the curb, hammering in concrete pins and then using something such as nylon loops to attach the tube to the pin is the best way to anchor tubes on these types of roads.



No curbs — Driving an 8" to 12" landscaping spike into the shoulder with a nylon loop attached to it that wraps around the tube will work as an anchor.



Asphalt — Driving a 2" to 3" ribbed surveying nail into the asphalt pavement will work as an anchor. Surveying nails are a nearly universal anchoring solution, but the nails can come loose on high speed/high traffic roads in warm weather.

Securing the tube to the road surface to prevent the tube being pulled up by passing cars:



Paved and dry — Use tape to secure the tube to the road. Some companies use sticky tar, mastic tape. We don't like it because it leaves a big mess on the tubes and we prefer sticky duct tape. Gorilla brand tape from Home Depot works well. Place one strip of road tape 4 to 6 feet (1.5 to 2 meters) apart for the length of the tube.



Gravel, or when a road is too wet for tape — Hammering in either spikes or pavement nails with nylon straps wrapped around the tube should be done at several points along the tube on the road.

The number of vehicles, the speed they're traveling, and the width of the road will determine how much tape, or how many loops are required. Also, make sure the tube lays tight to the road to avoid it getting snagged on passing cars. We typically place tape on the lane lines and in the middle of the lanes, so about every six feet.

For anchoring loops, you can cut $\frac{1}{4}$ " nylon rope into 18" lengths and tie the ends. While there are several metal clamps and loops on the market, we've found metal devices end up cutting the tubes over time and are not worth the hassle or expense. We prefer nylon rope loops as being gentler on the rubber tubes.

As mentioned earlier, we recommend using 50-foot-long tubes. Short tubes can send strong air pulses to the piezo sensors which damage them, and longer tubes can end up with weaker air pulses the piezo sensors don't register.

If the road is wider than fifty feet, place a counter on each side of the road and anchor the tube ends in the center of the road. To our knowledge, all tube manufacturers recommend 50-foot tubes but check their documentation because the tube length can affect the accuracy of the data collected. The location of the tube counters will also depend on what there is to secure it to, such as street signs, utility poles, trees, etc.

No matter what type of hardware you use, always make sure to use chains or coiled cables along with locks to secure the hardware to something on site. If parking is allowed on the street where you're setting up the counter, consider placing a small sign informing drivers to not park on the tubes.

Orange cones can also be placed on the tubes to try to prevent cars from parking on them, but you run the risk of the cones getting stolen. Also, for tube counters, we recommended not installing them during or around snowy weather, which often means the presence of snowplows. Similarly, check street-sweeping schedules. Street sweepers spin the tubes and break them right off.

Below is our How-to Checklist for road tube installation:



Placement — Secure the closed-off end of the tube and then carefully pull the tube across the road. Pull the tube, so it's lying flat and straight but not overly stretched, to avoid tearing the tube. Secure the other end via spikes and nylon straps or concrete pins and nylon loops. Don't tape or strap it down anywhere else just yet.



Connect — Plug the open end of the tube(s) into the tube counter to ensure it's working when vehicles drive over it. If you're doing speed, directional or classification counts, two tubes will need to be placed at a known distance apart. We typically install the tubes two feet apart, but different hardware manufacturers may have different recommendations, and you should always check the hardware manual.

A single tube is enough to collect daily traffic volume, but won't provide directional, speed, or classification data. If the tube counter is not recording, it may mean the tube has leaks and will need to be switched out with a different one.



Secure the Tube — Once the tubes and counters are confirmed to be working, further secure the tubes to the road using tape if possible or by wrapping nylon straps around the tube at a few points and securing the straps to the road with spikes or pavement nails.



Observe — Watch as vehicles pass over the tubes to determine if the tubes are secure enough. They shouldn't be bouncing or swaying much when semi-trucks go over them. High volume and high-speed roads will need more securing with tape or straps than low volume, low-speed roads.



Secure the Counter — After you confirm the counter is working properly, lock the counter to a sign, post, or tree and roll up any excess tube neatly next to the counter.



Paperwork — Using the site paperwork previously described, write down the location, layout, and time you installed the tubes, as well as the tube counter identification/serial number.

MANUAL COUNTS

When doing manual counts out in the field, the most important thing is letting everyone know exactly where they need to be and what they'll be doing there. The second most important task is making sure they get to their intersection about 15 minutes early. This extra time allows the data collectors to get settled and prepared and it also gives them a chance to see how the intersection operates.

If there are several groups of people doing different counts at several locations in an area, as mentioned before, we recommended setting up a central meeting spot before and after the count. At this meeting you can distribute and collect count boards or sheets and make sure everyone is on the same page regarding what they need to do, as well as making sure they know how to operate the equipment they'll be using.

It's also a good idea to make and distribute signs to the data collectors that say something to the effect of "Traffic Counting in Progress." The data collectors can put these signs in their vehicle windows or doors if they'll be counting from their vehicles or next to them if they're sitting outside. The sign helps by letting passersby know what is going on and the person sitting around with mysterious equipment isn't up to anything too fishy.

VIDEO RECORDING WITH MANUAL COUNTING IN THE OFFICE

Video cameras installed at an intersection should typically be between 30 and 50 feet from the edge of the intersection. The installation distance may change depending on the specifications of the system as well as the intersection geometry.

Typically, cameras can be attached to street signs, utility poles or mature trees. Also, try to point the camera north so it won't directly face the sun at dawn or dusk because direct sunlight can overwhelm the camera.

Once you find a location with a suitable view of the intersection and properly install the camera, make sure to set the recorder to record the proper time interval, and an SD card or USB drive is ready to record the data.

Our COUNTcams record continuously to remove the chance of programming the camera system incorrectly, which happened more than we care to admit with previous models of camera systems. Lastly lock up the recorder tightly and out of the way of pedestrians.

Then use the paperwork previously prepared to record the location, orientation of the camera, the field of view, the time of installation, as well as the recorder, SD card or USB stick identification numbers.

HARDWARE REMOVAL

Once the data collection period has ended, you need to pick up the equipment, which is usually a quick and simple process. Be sure to pick up all the equipment, including all tape put on roads for road tubes. Use the paperwork with the installation notes to double check everything, mark the pick-up time, and make a note of any issues.

Again, keep safety in mind when working in roadways or on the sides of roads. It's a good habit to do a quick check of hardware and tools after pick-up (and after installation). We've lost more than one hammer on the side of the road.



STEP 4

DATA PROCESSING

Once the data collection gear, or manual count sheets, have been collected it's time to extract and process the data into a useful, readable format. Some data collection equipment comes with software that can create reports highlighting useful information or can quickly transfer the data into an easy to use format. Either way, if this data is going to a client, it will at some point need to be compiled into an easy to follow format. Creating a report is a professional way to deliver your company's product and adds credibility to the results. Remember to include your company's logo and contact information.

AUTOMATIC COUNTS

(TUBE COUNTERS, RADAR COUNTERS, MACHINE VISION)

For automatic counters, assuming all the equipment functioned properly, data processing is quite simple. Tube and radar counters usually have software associated with them to quickly download the data from the counter and put it into an easy to read format, such as a spreadsheet.

Add details to this document such as the street name location, layout/orientation (e.g., radar counter height, tube spacing, etc.), dates and times, and possibly a site code. Several systems even allow you to include GPS coordinates or photos in the document.

You may need to set other data preferences for the data reports such as speed data, classification data, directional volumes, and time intervals. The final reports generated from these software programs often analyze the data and give useful summary information such as peak periods and various percentiles for speeds.

Since not all programs give this useful summary, you may need to do some work on the data in a spreadsheet. For machine vision video systems, you may need to upload the videos to a cloud-based system for data processing.

VIDEO RECORDING WITH MANUAL COUNTING IN THE OFFICE

You'll need to watch the video and manually count the cars if you don't send your videos to a processing service such as COUNTcloud. Depending on the system you use, there may be a software program which allows data processors to watch the video at various speeds and record the data using a generic QWERTY keyboard. Better systems will come with an external proprietary keyboard designed specifically for counting traffic, such as the COUNTpad. If the company you're working for doesn't have a system like this, the counts can always be done with a counting board or on paper while watching the video on a computer.

Using video instead of manual count boards in the field is a good way to reduce the number of people you use on a project, as well as to provide an auditable system for quality control. Also, since the video speed is variable, it's quite likely you'll save staff time doing the counting on fast-forward speed. We average 2x speed on intersections with traffic signals and 4x speed on intersections with stop signs, meaning you'll have a 50% to 75% reduction in time you need to pay people to perform manual traffic counts.

Some services, such as COUNTcloud will process this video data for a small per hour fee. Using COUNTcloud can further free up payroll, and staff, as well as allow you to scale up easily for larger projects.

Once the video is watched and turned into traffic count data, it can be exported from the software or count board into an easy to read format, such as a spreadsheet. Then, just like the data collected from automatic counts, some labeling may need to be done to include with the appropriate summary statistics.

MANUAL COUNTS

Manual traffic counts conducted with a counting board will need to have the data exported to a readable format as explained before.

Once you download the data, it can be labeled as needed and a report can be created by either using the report generator in the software or by exporting it to a spreadsheet to be manually arranged later.

If you did the count with pencil and paper, it would need to be manually entered into a spreadsheet and then arranged into a readable report.

Because manual counts are extremely time-consuming, the industry is moving away from manual counting to video-based counting. Despite this, manual counts are still a good option if you only do a handful of counts per year.

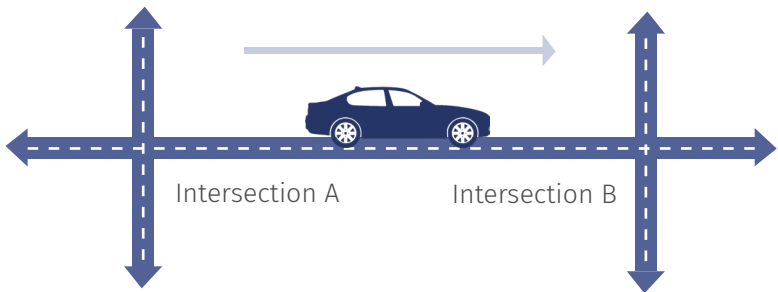
STEP 5

DATA QUALITY CONTROL

Before you send the data to your client or use it for your purposes, it's extremely important to check the quality. First, check the summary statistics from the data report. Do they make sense? If the report is saying the average speed on a 30 mph road is 72 mph, there's probably some bad data in there messing things up. For volume counts, scan through each interval and make sure the numbers look reasonable to you. For example, on a commuter road, are the big volumes going towards the city in the morning and then leaving the city in the afternoon? If not, there may be a problem.

When the traffic counts are from multiple locations near each other, the data between the locations should be compared to see if they balance.

For example, if 300 cars leave intersection A going towards intersection B, you should have about 300 vehicles at intersection B coming from intersection A.




It may also be a good idea to compare the new data to historical data. A good resource is the city's ADTs (daily traffic volumes). In Minnesota, all levels of government are required to collect daily traffic volumes on the collector and arterial roadways at least every four years, and many jurisdictions around the world have similar policies.

Comparing the new volumes to the historical volumes can illustrate changes as well as point out possible problems. Daily traffic volumes grow about 2% per year in our region, but volumes can increase much faster in a developing area. When the data doesn't look correct, the first thing to do is to go back and talk to the person who collected the data.

It's possible they collected it incorrectly, and you can correct it retroactively (e.g., they turned their count board in the wrong direction, and you need to rotate north, south, east, and west).

If the data came from a video, another look at the video could quickly confirm whether the data is right or wrong. For example, we had a leg of an intersection with no outbound data during the morning rush hour.

We reviewed the video and realized the data was correct because the leg of the intersection with zero volume was from a small shopping center which was closed in the morning.



This type of situation is one of the many reasons the traffic data collection industry has been moving towards video-based counts. If you can't explain why the data doesn't look right, you should probably do the count over to make sure you're using accurate data.

A quick half hour recount from the video can save a lot of headaches later. The ability to do a spot check is a big advantage of using video instead of doing manual counts.

STEP 6

EQUIPMENT MAINTENANCE

After getting the data collection equipment back from the field, it's important to make sure it's ready to go for the next count. Hopefully, your review of the data shows no issues. But if you do find errors, you may have faulty equipment. We recommend setting the questionable hardware up on the road adjacent to your office for an hour or two as a quick check. If the equipment keeps producing bad data, pull it out of the rotation and either fix it or contact the manufacturer. There's no reason to test hardware every time you use it if your data looks reasonable, but it's a good idea to quickly check the power and settings of all hardware before leaving the office for a day of field setups.

To make sure you have power, we recommend putting rechargeable hardware on chargers as soon as possible after use. If your hardware has replaceable batteries, carry spare batteries in your work vehicle. The number one tech support issue we have at Spack Metrics ends up being dead batteries, and it's easily avoidable.

One item you should thoroughly check is road tubes. Even if the data obtained from the road tube was good in the past, tubes don't last forever and will eventually wear out and lead to bad data. We recommend you physically inspect the entire length of the tube after each use.

Look and feel for any nicks or tears in the tubes. If you find a small nick, and it doesn't look like it will grow or become an issue, a small piece of tape can be placed around the tube to stop it from growing. If you find larger cuts or tears, it's best to remove the tube from use. When the tear is near the end of the tube, just cut it off and keep using the tube (you may need a new end plug).

Just make sure to mark the tube in some way to show it's an odd size. Keep in mind certain types of tube counters require certain lengths of tubes. If the tube has multiple holes near its middle, it's time to throw it away and order a replacement.

Put the pressure gauge into the open end of the tube and use the air compressor to fill the tube up to about 15 to 20 psi. Watch and listen for about 10 seconds. If the pressure in the tube stays constant and it doesn't sound like any air is leaking out, the tube is fully intact. If the gauge starts dropping, it means there's a leak in the tube. Another hand check while the tube is pressurized is the best way to find this new leak.

If the leak is mid-tube, as mentioned before, it can either be cut down or scrapped. If the leak is at the end, then the plug will need to be replaced. If you don't have a pressure gauge, tubes can be placed in a bucket of water to see if compressed air put into the tube leaks out and creates bubbles. A pressure gauge is a lot less messy.

Several companies sell road tube simulators to test automatic tube counters in the shop. We recommend VehicleCounts road tube simulator. The simulator sends air pulses to the counter in defined patterns. Then the counter's data is downloaded and compared to the recorded pattern.

It's a good idea to do this at least once a year for all tubes and

tube counting equipment. Since this testing equipment is often expensive, it might be a good idea to simply rent the testing equipment once a year when the hardware won't be in use.



RESOURCE 1

PRICING

A lot of data collection and consulting firms charge based on time and materials, which usually includes an hourly rate per employee as well as mileage, disposable materials, and a rental fee for equipment. Based on client feedback, we went away from this model early on at Traffic Data Inc and went with a unit price per count. We developed a standard price list for our metropolitan area based on unit pricing.

We recommend tailoring this price guide to reflect the cost incurred by your company, and with consideration given to average travel times between sites in the area. With the video based counting system we use, we don't think about how many people it will take to do a count, as now almost all our counts are done by one person.

Instead, we base our pricing on the type of traffic control. We know counts at stop sign controlled intersections go faster than counts at signal controlled intersections, and these go faster than counts at roundabout controlled intersections.

A standard price list means we make a little more on projects close to our office and make a little less on projects further away. However, it makes our client's job, as well as ours, a lot easier. They can look at the matrix and do the math themselves. They don't need to call us until after they get authorization to proceed from their client or have made their decision to go with us.

Just because we have a standard price chart doesn't mean we don't sometimes change those numbers depending on the job at hand. For large projects, we will discount our prices to reflect the economies of scale.

We also tack on a mobilization fee to cover the extra time and mileage associated with counts outside of our metro area. Since we've incorporated video based turning movement counts, we've been able to lower our price for a 24-hour turning movement count to what we used to charge for am/pm two-hour counts at an intersection.

We believe longer duration counts provide much more value to the engineers who are using the data. Also, the incremental cost to add those extra hours is small now.

We also raised our prices on tube counts due to the inherent costs and the low demand. Agencies in our region still do a lot of tube counts, but they typically do them in-house with their staff. On engineering driven projects, we're nudging the video-based counts, as they're more cost-effective for both the customer and us.

When developing your company's price matrix, it's a good idea to factor in your company's costs along with the going market rates in your area. Ideally, technology will improve lowering prices while simultaneously increasing profit margins.



Someday, I believe 48-hour turning movement counts will be the default. Both tube counts and two-hour peak period turning movement counts will look antiquated. Right now, 13-hour counts are the default in Minnesota, and there's increasing demand for 24 and 48-hour turning movement counts.

Someday, computers will replace humans doing the counts, and the prices will come down even more. We expect week long turning movement counts to be the norm before we retire.

RESOURCE 2

DATA COLLECTION EQUIPMENT BRANDS

There are several options available for traffic counting equipment. Selecting the proper type and brand of equipment for your company depends on a number of factors. Good questions to ask are: How many people are available to do counts? How many people will be on staff full time? What types of data do you need to collect? Who asks you to collect the data? How quickly do you need the data?

Here are three good places to start your research:

TrafData.com

If you only do a couple of low volume turning movement counts per year, we recommend the TurnCount app. If you do more than a few counts per year, the CountCam from SpackSolutions.com is probably a more effective tool for you.

VehicleCounts.com

If you only do a few tube counts per year, we recommend the Pico 2500 tube counter as a cheap option. If you need four or more counters to complete your traffic counting, the wayCount counter from SpackSolutions.com is probably a more effective tool for you. Vehicle Counts also sells a road tube simulator we recommend for testing your tube counters accuracy.

SpackSolutions.com

I've been in the car counting business since 1993 and founded SpackSolutions.com to create and sell the best traffic counting equipment on the market. Go to SpackSolutions.com to schedule your free consult call to see if our gear is a good fit for you. We developed the COUNTcam, COUNTcloud, COUNTpad/COUNTpro, Video Editor, and wayCOUNT all to meet our own needs.