Designing an Urban Forest Inventory System
for a Small Municipality:
A Case Study of Falls Church, Virginia

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To all the people who helped me get here:
***You* know who you are,**
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and
***I* am grateful.**

THANK YOU VERY MUCH!

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INTRODUCTION

The City of Falls Church, Virginia is an independent city in the Washington, DC metropolitan area, with a population of 13,600 within its two square mile jurisdiction. The City's residents are justifiably proud of their beautiful and extensive urban forest. Falls Church has been a Tree City USA for thirty-six years, longer than any other community in Virginia, and the protection of its mature trees and expansion of its tree canopy are key goals in the City's Comprehensive Plan (City of Falls Church, 2005).

In 2012 and 2013, city staff, council members, Tree Commission members and other city resident volunteers worked with a team of independent consultants to create a strategic plan for managing the urban forest. One of the high priority action items identified in that plan was the creation of an inventory of the City's trees to "improve understanding of the state of the urban forest, facilitate planning of capital budgets and development plan review, and…enable effective work planning and risk management." (City of Falls Church, 2014).

This report describes the development and testing of a tree inventory system for the City using the ESRI ArcGIS data mapping platform. The database design and the procedures for data collection are described and illustrated. Strengths and limitations of the ESRI software and hardware options for the purpose of collecting and displaying tree inventory data are considered, and recommendations are made for further development of the inventory system. It is hoped that this case study will be of use to other entities considering the creation of a complete or partial tree inventory.

BACKGROUND

Urban Forests as Assets

Urban forests are high-value manageable assets that can deliver a remarkable return on investment. A recent study of the urban forest of the City of Falls Church using the US Forest Service i-Tree Eco protocol (USDA Forest Service, 2011a) indicated that the total replacement value of its public and private trees is more than $146 million (Wiseman and King, 2012). And according to the US Forest Service (Peper et al., 2009), the benefits of landscape trees to a municipality from reductions in stormwater runoff, air pollution and energy use, and from increased property values, may be as much as three times greater than the funds invested in tree care. Trees in urban areas also deliver substantial benefits which are not readily quantifiable in

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monetary terms but are clearly of significant value, such as stronger communities, healthier residents and better business.

Urban Forest Inventories

Effective management of any assets requires information. Information makes it possible for managers to set realistic goals, devise plans to achieve them and monitor progress. The information we need in order to manage the urban forest can be derived from data obtained using two types of assessment: top-down and bottom-up (USDA Forest Service Northern Research Station, 2013).

Top-down data obtained by analyzing remotely-sensed imagery acquired by satellites or aircraft can provide information about the extent and distribution of the urban forest canopy. Such information can, for example, be used to estimate the ecosystem services the urban forest provides and support decisions about funding its management. It can guide policies such as those related to canopy protection and replacement during development. And it can be used to identify areas where canopy cover should be protected or could be increased by targeted planting programs and outreach (Wiseman and McGee, 2010). However, the systems currently available cannot provide reliable, detailed data about tree species, health and structure (Nielsen et al., 2014). These data, which are essential for risk and cost management, must, for now, be gathered bottom-up, from ground level.

Ground level inventory data from a small random sample of the tree population, such as those collected using the USDA Forest Service i-Tree Streets protocol (USDA Forest Service, 2011b) can be sufficient to provide useful estimates of the tree count, species diversity, value and benefits provided by the urban forest. An inventory of this type was completed in the City of Falls Church in 2011 (Wiseman and Bartens, 2012). Additional general data about maintenance needs can also be collected using this program. However, if an inventory is to be used for planning and tracking work or for risk management, then condition and maintenance information is needed about individual trees and groups of trees.

A complete, ground-based inventory of a city's urban forest, in which every tree is counted, mapped, identified, measured and assessed, may be considered the gold standard for gathering data to support urban forest management decisions. The level of detail it provides cannot be obtained using other techniques, and the data it encompasses can be chosen to provide detailed

information for evaluation of the intrinsic value of the forest, the benefits it provides, the risks it poses and what resources will be needed to increase the benefits and minimize the risks. It can support long-term planning, such as managing the distribution of species in the forest, and make day-to-day management, such as deciding which trees to work on, when and where, more efficient. It can provide justification for budget allocation requests and demonstrate the value of the forest to city residents. It can also improve emergency preparedness and response to threats such as diseases and pests (Bond, 2013).

Unfortunately, the term "gold standard" is appropriate: an inventory of this type can be very costly to create (Wiseman and McGee, 2010). For most municipalities, a truly complete inventory would be impractical. In the unlikely event that resources were available to assess every tree individually (Falls Church has an estimated population of almost 60,000 trees on its two square mile area (Wiseman and King, 2012)), many are on private property; getting permission to access them would be time-consuming, costly and probably not possible for some trees. Analyzing and interpreting the data collected would require significant resources. Maintaining the data would also be extremely difficult, since the population would almost certainly change faster than data could be updated.

In most cases, a partial inventory which covers a specified population of trees will typically be sufficient. A particular geographic area, a defined size range or, for pest management, selected species of trees, might define the population to be assessed. For municipal authorities, the top priority populations for management are usually the street and park trees (Roman et al., 2013).

The more data are gathered about each tree, the more expensive the inventory will be. A recent study identified 148 different parameters that might be considered for inclusion in a ground-based inventory (Östberg et al., 2013). Obviously, it would not only be impractical to record 148 pieces of data for every tree, it would not be useful. The types of data gathered must be prioritized according to the information the data are intended to provide and the cost of gathering them.

Inventory Quality

The quality of the inventory is of paramount importance (Bond, 2013), and may be judged against the following criteria:

1. *Data needs*

   The inventory should contain the data needed to generate information for management decision-making, and in order to manage inventory costs, the data collected should be limited to that which will be used. This includes setting clear criteria for which trees to include in the inventory, which may, for example, be related to city boundaries, property limits and Right-of-Way information. The data collected about the trees (and other features such as planting spaces) should only be those which will generate information for management decision-making. Species, diameter, condition and maintenance needs are typical information needed for day-to-day urban forest management. Other size information, location characteristics, risk ratings and images may also be considered for inclusion.

2. *Data definition*

   Data definition is a crucial consideration. To ensure consistency across time and between different data collectors, standards for determining the value of each attribute to be recorded should be clearly defined and incorporated into the inventory system. For example, standards for quantitative attributes such as diameter should indicate the accuracy required, the equipment to be used, and the procedure for measurement, including how to measure trees that are not vertical, single-stemmed and on level ground. Standards for qualitative attributes such as condition and health require precise, clear and careful definition. Illustrations may be useful to supplement written descriptions.

   Early in the inventory collection process, data entered in the system should be cross-checked by the inventory data users to ensure that the standard definitions are in fact appropriate to their management needs. They should also check periodically and when new data collectors begin work, that the established standards are being correctly applied.

3. *Ease and accuracy of data entry*

   The inventory system should support easy and accurate data collection and entry. Drop-down menus on electronic data entry devices, or check boxes on paper data sheets, help to speed the process and minimize errors and inconsistencies. Automatic error checking by the data entry software, such as preventing data duplication or the entry of the wrong

data type in a field (such as text in a number field) can be very helpful. Review of entered data, and cross-checking by different collectors, can be used to look for data entry errors.

The more difficult it is to collect and update data, the less likely it is that the inventory will be completed and maintained. The need for special equipment, any limitations imposed by the equipment or system, and the time taken all have a significant impact on the likelihood that data will be entered and updated.

4. *Data storage, retrieval, and analysis*

It is important to ensure that the inventory data is stored securely. "Cloud" data storage, and local and off-site back-ups may be needed. It is also essential that data can be readily retrieved and analyzed to fulfill its function of providing information. If the inventory does not provide information easily and promptly, it will not be a useful tool for management.

CITY OF FALLS CHURCH TREE INVENTORY DESIGN

The City of Falls Church already had information about canopy cover and the overall structure of the urban forest from sample i-Tree Eco and i-Tree Streets inventories done in 2011 (Wiseman and Bartens, 2012; Wiseman and King, 2012). However, the City's urban forest managers considered that an inventory containing detailed data about the condition and work needs of "all publicly-owned and actively-managed street, park and public facility trees", as recommended in the urban forest strategic plan (City of Falls Church, 2014), would provide them with information that would enable them to improve their management processes.

Information Needs for Tree Management in the City of Falls Church

The City of Falls Church has two urban forest managers: the City Arborist and the Greenspace Manager. The City Arborist is primarily concerned with long-term management of the urban forest as a whole; the Greenspace Manager has operational responsibility for the day-to-day maintenance of the trees and other vegetation owned or cared for by the City. The two managers need access to the same information, but focus on different details.

In order to maintain the forest in the long term, the City Arborist needs information about the overall canopy cover and details about what different species, sizes and ages of trees contribute to that cover. Although street and park trees constitute only a fairly small proportion of the City's

tree population (perhaps of the order of 14%),[1] they are the ones over which the City has direct management control. Data about City-managed trees may also indicate broader forest management needs. For example, pest problems in street trees could signal an infestation of the wider population.

The City Arborist can, in most circumstances, only indirectly manage the majority of the City's forest, which is located on private property. For example, although Section 44 of the City Code of Ordinances (City of Falls Church, 2009) allows the City Arborist in an emergency to prune or remove unsafe trees from private property, the normal procedure is to notify the tree owner that such work is required, and allow a reasonable time for it to be done on a voluntary basis. The City Arborist also manages the overall forest population through the implementation and enforcement of policies that require property owners to protect canopy cover during development, and through outreach to encourage public support for and involvement in maintaining the urban forest.

The top management priorities of the Greenspace Manager are the safety and aesthetics of the City's street and park trees. Data about the location, condition and structure of individual trees are essential to generate information about which areas of the City should be targeted for maintenance activities and to identify the resources needed. For example, a map-based inventory of juvenile trees will be invaluable for summer irrigation planning, and timely information tracking the incidence of health and pest problems can be very useful to proactively manage problems before they spread.

These types of information can all be generated from data gathered as part of a ground-based inventory.

Inventory Data Collection and Analysis System
Commercial software specifically designed for tree inventory collection is available, but City managers were concerned that it would not be compatible with existing data and work

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[1] A 2003 inventory recorded 6932 City-managed trees, 2847 of which were street trees. The 2012 i-Tree Streets report (Wiseman and Bartens, 2012) estimated that there were almost 4000 street trees, and the i-Tree Eco study that same year (Wiseman and King, 2012) estimated the total tree population to be about 59,700 trees.
This would suggest that, if the number of non-street trees managed by the city had not changed between 2003 and 2011, there would be about 8000 city-managed trees in total, constituting about 13.5% of the City's tree population. Obviously no element of the population is static, and using data from surveys taken at different times gives no more than a likely order of magnitude of the proportions of City- and privately-managed trees.

management systems. The ongoing costs of software maintenance and data storage for an independent tree inventory system were also considered to be prohibitive.

The City already has a considerable collection of data stored and mapped using the ESRI ArcGIS Platform (City of Falls Church, 2015). Using this platform to collect the tree inventory data ensures that it can be seamlessly combined with other map-based city data such as City and property boundary line mapping, street sign locations and the stormwater management system.

The "Collector for ArcGIS" application (ESRI, 2015) provides data collection capability for programs associated with the ESRI ArcGIS Platform including ArcGIS Online, Portal for ArcGIS, and ArcGIS for Server with an ArcGIS organizational account. The application exists for both Windows- and iOS- based data collection devices, so it will be compatible with whichever system the City decides to use in the future. Multiple users can enter data about different features simultaneously so, for example, if the City Arborist is collecting tree condition data in one part of the City, the Greenspace Manager can simultaneously enter records of work done in another. Stored data can be retrieved through ArcGIS online mapping or as tabulated information using ArcMap. Data can also be exported for analysis to Microsoft$^®$ programs such as Access or Excel.

For this project, the database and application software were configured by the City's GIS Analyst. Configuration was reportedly straightforward, and made use of a new feature of ArcGIS and the Collector application which allows the user to create and update data in multiple related tables. This feature was used to allow the database to store historical condition and work data for each tree.

Inventory Data Selection and Structure
The data to be recorded in the inventory were selected by the urban forest managers based on the information they want to have in order to manage and maintain the trees. A list of data types and definitions was created, reviewed and edited using the suggestions in the International Society of Arboriculture (ISA) Best Management Practices (BMP) for Tree Inventories (Bond, 2013) and the knowledge and experience of the City Arborist and Greenspace Manager (both ISA-certified arborists) and the author. Collection of the dataset was then field-tested on at least 20 trees, and revisions were made as necessary. Several iterations of this process were required to establish a dataset which appears to meet the needs of both managers. The final data set and structure are

shown in Figure 1, and data definitions are tabulated in the inventory Field Manual in the
Appendix. The functions of the different record types are as follows:

1. *Static Record*

   The Static record for each tree contains information which does not routinely change. The location and species of the tree, the type of site (or land use) and presence or absence of utilities, when it was planted and by whom, the plant stock type and, ultimately, the year removed will normally be entered in the field. Photographs may also be attached to the Static record. Other data types in the Static record, such as the owner of the tree and who maintains it, and any special designations such as "Specimen" or "Noteworthy," need to be determined by consulting city records and would typically be entered on a desktop
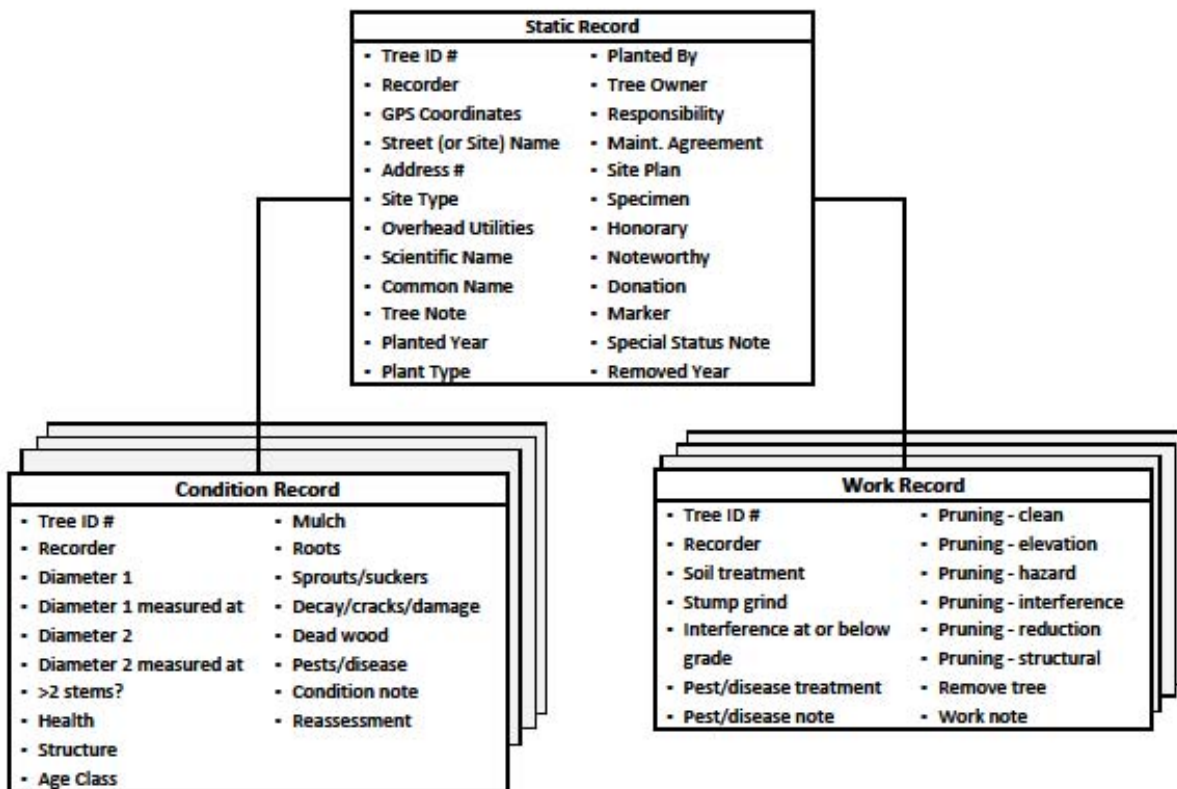
Figure 1: Final inventory data set and structure. Each tree has one Static record, which does not usually change until the tree is removed. Multiple Condition and Work records created on different occasions can be attached to a single Static

2. *Condition Record*

   A new Condition record for the tree will be created each time it is assessed, so that the history of the tree's condition can be traced through time. Size, recorded as diameter at breast height (DBH, the diameter of the tree trunk 4'6" above the ground), is the only quantitative element in the Condition record. Assessments of health, structure and age class are made separately, rather than being combined to give a numerical condition rating, because their impacts on management actions are different: health problems may require soil testing and treatment, but structural issues typically require pruning. The adequacy of mulching, and any observations of conditions which might indicate the health status or affect the structural integrity of the tree can be noted using dropdown menus. None of the data are required for successful creation of a record, so even if time only allows one element of the record to be assessed, it can be recorded for future reference.

   The record allows for the addition of a text note so that observations leading to ratings of less than good health or structure and conditions to be monitored or addressed can be briefly explained. An appropriate timeframe for reassessment can also be indicated using a dropdown menu.

   The application software does not allow photographs to be attached directly to condition or Work records, but any number of photographs can be attached to the Static record for the tree.

3. *Work Record*

   Work records may be created either when work is required, or when it has been done. For each work type, the dropdown menu allows the user to indicate the timeframe within which the work is needed, or to select "Done" when work has been completed. The work types were selected based on the types of maintenance listed in the ISA BMP for Tree Inventories (Bond, 2013) and those which might be done in the City. Established City trees in good condition are unlikely to receive any maintenance attention other than annual mulching unless they interfere with road signs or utilities. Juvenile trees are watered and mulched, and pruned to achieve a strong structure and provide clearance for pedestrians and traffic. Postmature trees may need pruning to remove dead or hazardous

branches, but management interventions are very unlikely to extend to cabling and bracing or lightning protection. Trees that show signs of stress are targeted for more frequent monitoring for pests and disease than those in good condition. Treatment for pest control is very seldom necessary, but provision was made to note it both because of the importance of tracking treatments and because of the public attention such actions may attract.

As with the Condition records, a new Work record is created each time work is noted as needed or completed, so that the history of work on the tree can be traced through time. A note field to describe the work in greater detail is included, and a separate note field for pest identity and treatment details is also provided.

Field Data Collection

While the design of this new inventory was underway, data from a previous complete inventory, done in 2003 and subsequently abandoned and lost, were rediscovered. Fortunately, it was possible to import these data into the new system, thus preserving historic data about the trees and pre-locating and identifying the species of many trees still standing in the City. This made data collection much easier, since the Static record for many trees already existed and only needed to be reviewed for accuracy and completeness, and updated if the tree had been removed.

Data collection in the development phase of the project was primarily used to test and refine the system. However, in order to ensure that the data collected were also useful *per se*, priority was given to the two major routes which pass through the center of the City, Virginia state route 7 and US Route 29. These are the most-heavily used streets in the City both for pedestrian and vehicular traffic, and therefore have the highest priority for public safety.

Perhaps surprisingly, one of the most challenging steps in the inventory process was to determine which trees would be included. The inventory scope defined in the City's Urban Forest Strategic Plan, that of "all publicly-owned and actively-managed street, park and public facility trees" (City of Falls Church, 2014) seems at first reading to be quite clear, but it is not, in fact, straightforward to determine which trees fall into that population.

Trees in parks and within the grounds of City facilities are clearly publicly-owned, and active management can be confirmed either by examination of past Work records or simply by visible

evidence of mulching or pruning. Typically, on City property, only trees which are in naturalized zones or forest fragments and well away from paths and trails are left unmanaged.

The determination of which street trees to include in inventory presents a more complex challenge. Ownership and management responsibility are not easy to establish, and trees which are neither publicly-owned nor actively-managed may be in or near the Right of Way and have significant potential impacts on the safety and aesthetics of City streets.

The ownership of street trees depends on property boundaries and their location with respect to the Right of Way. The first step in determining tree ownership is therefore to establish these data. Although the City has recently mapped property lines (for Stormwater Utility Fee calculations), it does not currently have a reliable GIS-based Right-of-Way map. A paper map of the whole city indicating the width of the Right of Way is available, but it does not establish its location in relation to the street infrastructure. The situation is further complicated because trees in the Right of Way may be publicly-owned and maintained, privately-owned and maintained, privately-owned but maintained by the City, co-owned by the property owner and the City with maintenance costs shared – there are many possible permutations of ownership and maintenance responsibility, and the relevant records are not always easy to locate. Definitive ownership can only be established by reviewing individual property plats and checking for records of ownership or maintenance agreements, which is impractical in the field.

During the development phase of this project, all trees on City facilities or with any part of the trunk within 15' of the street edge, or judged likely to impact traffic or pedestrians if they were to fail, were included in the inventory. Although not all of these trees can be directly managed by the city, the City Arborist can require the owner to act if they are in an unsafe condition (or charge the owner for maintenance or removal performed by the City). This population definition meant adding a considerable number of established trees that are on commercial and residential property to the existing 2003 inventory data. There were also many new street trees to be added, planted as a requirement of property development and grading plan agreements.

Data were entered using the ESRI Collector application on either an iPhone 5 or an iPad Mini. For trees already in inventory, the tree marker was located on the map and selected. For trees not previously inventoried, a new tree record was created simply by touching the map on the screen and selecting the option to collect at the location selected. With the tree record selected, a new

Condition record could be opened, and the trunk diameter measurement (diameter at breast height, DBH, determined to the nearest 0.5" using a logger's tape) entered. For inaccessible trees (on commercial or private property), the diameter was estimated, and a note added to indicate that the value was an estimate.

The tree was visually scanned from roots to crown on all safely accessible sides both during the approach and after measurement. In most cases, the tree's health status could not be readily assessed in the late winter season, but structure and age class were easily evaluated. Conditions were noted using the dropdown rating menus. The Notes field was used to record reasons for structural ratings other than good, or describe conditions needing further explanation. If work appeared to be necessary, a Work record was also created. The inventory field manual is attached as the Appendix.

All records were reviewed periodically during data entry on the collection device, and a sample was reviewed again on a desktop computer at the end of the day. In addition, a list of trees identified as being in poor and fair structural condition was provided to the City Arborist to cross-check the ratings.

RESULTS

On the two main City streets, 200 trees which had been inventoried in 2003 and 234 additional trees were assessed and entered into the ArcGIS map database between February 9th and April 29th, 2015. In that timeframe, only the data entry capabilities of the system were tested and developed. The results of the inventory design process will not be able to be truly evaluated until the inventory data are in use for management of the urban forest in Falls Church City.

In many ways, the system is performing well, but there are some key issues that remain to be resolved. It is useful to examine the system against the criteria for inventory quality described in the Background section of this paper, which begins on page 3.

Data Needs

The initial definition of the population to be entered into the inventory (all trees on City facilities or with any part of the trunk within 15' of the street edge, or judged likely to impact traffic or pedestrians if they were to fail) meant more than doubling the number of street trees included on the two major city thoroughfares. This means that the inventory will take more than twice as long as previously estimated to complete, and will be proportionately more expensive.

Examination of the Right of Way width on other streets of the City suggests that a 10' limit from the street edge will be appropriate for most streets, so the proportion of added trees may be lower.

It is also hard to judge which additional trees (beyond the 15 or 10' distance from the street edge) are "likely to impact traffic or pedestrians if they were to fail". There are some very large front- and backyard trees in the City which clearly have the potential to fall into the street if they fail, and they are not typically accessible for assessment. It was decided that this part of the tree population would not continue to be added as the inventory proceeds.

A significant proportion of the time and resources invested in this project was expended deciding what types of data should be included. Two data types were added as the inventory was field-tested. A field in the Condition record for roots had not originally been included, since action is seldom taken to address root problems. However, girdling and mounded roots were potentially a health and/or structural impairment for many of the trees on Broad Street (Route 7), and it seemed best to add it as a standard condition assessment rather than constantly using the note field to document the magnitude of a common condition. Structural pruning, a vital step in establishing strong, healthy trees, had inadvertently been omitted from the Work records, and was added on the third database modification. The datasets now seem to be complete, but it is only when the data are being used that it will become apparent whether everything needed has been included and superfluous data have not been collected.

Data Quality

Almost all of the data being collected are qualitative, making data quality management challenging. However, the standards for measurement and ratings have been defined briefly and clearly (see Appendix), and a single-page field reference has been created so that new users can readily calibrate their assessments against the standards. This is a practical approach for rapid assessment and is sufficient for management needs, but there will almost certainly be some overlap between ratings. A tree rated as being in "Poor" structural condition by one assessor might be categorized as Fair by another, but from the point of view of practical management, its exclusion from a list of trees in "Poor" structural condition is unlikely to be important if its rating is marginal.

By not requiring completion of data fields (a field left blank indicates that a condition was either not present or not assessed), the system retains the flexibility to record very brief or limited assessments. This does mean that, when checking data entry, it is only possible to determine if data were gathered about a particular tree, not whether information was inadvertently missed. Maintaining the option of rapid, if abbreviated, data entry was considered to be more important, to ensure that the database will continue to be updated whenever a tree is visited.

Notes fields were included in each record type. Their inclusion reduces the number of condition types that must be included, since rare conditions can be recorded as a note rather than having a dedicated data field. Interestingly, the ability to enter free text was rated by arborists as very important for urban forest inventory in Östberg's study of urban forestry parameters (Östberg et al., 2013), even though it increases the possibility of errors in data entry. The predictive typing feature on the data collection device can help or hinder the process, depending on how carefully the data gatherer monitors the suggestions and corrections.

Ease and Accuracy of Data Entry

Data collection for entry in the system is very straightforward. All of the data except DBH can be collected with no equipment beyond suitable protective gear and the data entry device. DBH measurement using a Biltmore stick, or estimation of diameter, would speed the process, but both managers wanted tape measurements. The City Arborist will use the data for health monitoring, and the Greenspace Manager will use it to specify and price contract work such as pruning.

Since no data fields are required to be completed, a considerable amount of useful data can be collected without even getting close enough to the tree to need any equipment. Up to twelve assessments per hour (with full data entry) were completed in this development phase.

Both of data entry devices tested worked well, although the iPhone 5 had significant advantages over the iPad Mini. The phone is easier to carry and to hold during data entry, and although menu navigation may require an extra step or two, it is not perceptibly slower. The small screen size is advantageous for visibility (especially when taking photographs) on bright, sunny days, and a phone is easier to shield and therefore more likely to work on a drizzly day when water droplets can interfere with touchscreen operation. The iPad battery lasts longer, but small, portable, back-up power supplies for iPhones are readily available.

A topographic map was found to be the best base layer for data entry, since it can be viewed at a larger scale than imagery. It may take a few minutes for the complete map to display when the application is first opened, but once the display is complete, upload to the Cloud is essentially instantaneous. Photographs sometimes take a little extra time to upload and occasionally need to be re-sent. If sending a photograph fails completely, it will be stored in the data collection device library, and can be uploaded later using ArcGIS Online.

It is in data entry that the system currently has its most significant flaws. When a new tree is added to the inventory, the Collector software cannot automatically create a new Tree ID number. A new number has to be created (the system chosen was to use the date followed by a two-digit sequential number tracked by the data entry operator), and duplicates are not automatically flagged. If a duplicate has been created, any Condition or Work records with that Tree ID number are attached to the first tree with that number. To correct the issue, a new tree record with a new number must first be created, adjacent to the actual tree location. The Tree ID numbers in the Condition and Work records can then be edited to attach them to the right tree. The record with the duplicate number is then deleted, and the new record moved to the correct location. Frequent data review is necessary to detect and fix the problem.

Another issue can also cause Condition and Work records to be misplaced. After a tree record has been created, the tree must be actively reselected before adding a new record, or the data will be attached to the *previous* tree selected. A quick check for trees with multiple Condition records on the same date will reveal the problem, which can be corrected by simply editing the Tree ID number in the Condition record.

These field data entry problems require vigilance and frequent review to avoid, which is not ideal, but the Collector application is currently under development, and it is hoped that the next version will not have the same limitations. In the meantime, operator awareness is essential, and is incorporated in the instructions for data entry.

Desktop data entry is also not yet as easy as had been hoped. Static records can easily be updated using ArcGIS Online, but Condition and Work records can only be edited on the data collection device. Software licensing issues have delayed development of this capability.

Modifications to the database structure, such as the addition of a new field for root condition, require downloading and re-uploading the data, which can cause some problems (for example,

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on one occasion, the photographs became temporarily detached from the tree records). However, such data manipulation should not be required once a satisfactory structure has been established.

Data Storage, Retrieval, and Analysis

The data are stored in ArcGIS, and backed-up with the rest of the City's map data. The Field Manual and other information are stored as metadata with the database, so the data should remain meaningful over time.

Data retrieval and analysis have not yet been developed beyond map-based desktop display of the data (see Figure 2). Tabulation and graphing for data analysis will be possible using ArcMap, or by exporting the data to Microsoft® Access or Excel.
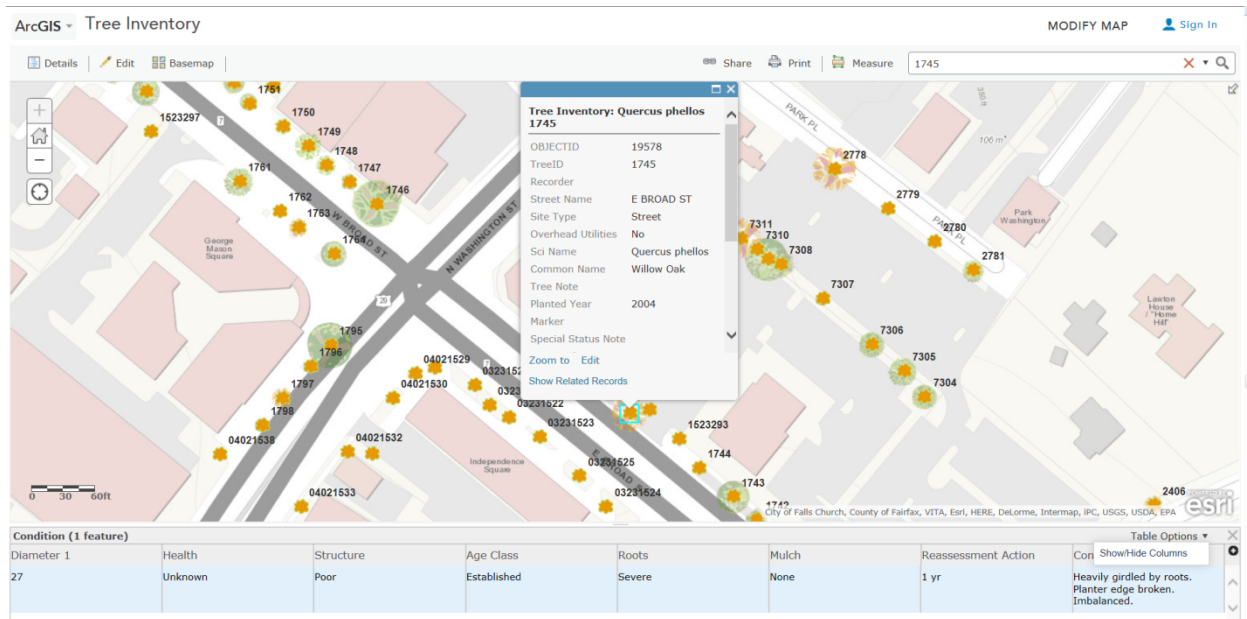
Figure 2: ArcGIS map screenshot of tree inventory data for Falls Church, showing tabular display of a Condition record.

CONCLUSION AND RECOMMENDATIONS

The design of this system has the potential to establish a readily-maintained, comprehensive inventory of trees on the streets and in the parks of the City of Falls Church. Because the dataset is tailored to the stated information needs of the City Arborist and Greenspace Manager, it is likely to be useful to them. They are therefore more likely to be motivated to maintain the data than a less-carefully designed system.

Its compatibility with the other map-based City databases means that the city is likely to continue supporting the hardware and software needed to maintain it, and the technical expertise

needed to manage them. It may therefore avoid the fate of so many urban forest inventories (including the City's own 2003 inventory), to be created but not updated or used for strategic management purposes (Keller and Konijnendijk, 2012).

Data entry is simple, and the manual has been designed to be suitable for self-study by an ISA-certified arborist, so that the inventory can be maintained in the event of changes in personnel. A one-day training program on tree structure, health and management needs, in addition to working with a certified arborist for one or two days, would be needed to train less qualified data gatherers (such as, for example, undergraduate students or Master Gardener volunteers). The database could, in the future, be made available to members of the public to enter data on their own trees. They would, of course, need to be barred from altering City data, but the engagement of volunteers in data collection is a key way to expand the data available about the urban forest (Roman et al., 2013).

For now, the top priorities for the inventory are to enter as much data as possible, and to set up standard queries and reports in ArcMap, Microsoft[®] Access or Excel to generate management information. The Greenspace Manager will be able to use the data even while it covers only a limited area of the city, but for the City Arborist, more extensive data will be much more useful. By creating standard queries and reports in the database, the burden of analyzing data on a regular basis can be very simple, encouraging its continued use.

The inventory alone will not provide all the data needed to manage the urban forest. It can provide tree maintenance information for the Greenspace Manager, and detailed data about that part of the forest managed by the City Arborist. However, for overall assessments, top-down canopy data are essential. Repeat i-Tree Eco inventories should also be used to gather data about the forest as a whole and track changes in its structure and function over time. If expansion of the inventory data across the City is not achieved over the course of the coming year, a repeat of the i-Tree Streets inventory could also provide useful information for estimating management costs and the resources needed to complete the database.

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APPENDIX: FIELD MANUAL

City of Falls Church Tree Inventory Field Manual

April 16, 2015

CONTENTS

Field Equipment List (1 page)

Procedure (1 page)

Field Reminders (2 pages, print double-sided)

iPhone Instructions (1 page)

iPad Instructions (6 pages)

Data definitions (10 pages)

April 2, 2015

Safety:

- Hard hat
- Reflective vest (with sleeves)
- Eye protection
- Steel-toed boots
- Water bottle

In case of emergency:

- City ID
- Health insurance ID
- Credit card
- Cash
- Mobile phone

Inventory tools:

- D-tape
- Tack hammer
- Loupe
- Pocket knife
- iPad, tablet or iPhone with external charger and cord
- Notepad & pencil

City of Falls Church Tree Inventory Procedure

April 2, 2015

At office, before leaving:

- Ensure devices are fully charged.
- Decide on streets/area to be inventoried.
- Arrange transport if needed.
- Load up with equipment (see Equipment List).
- Test data display and data entry functionality outdoors.

In field:

- Visually scan tree health and structure as you approach and walk round tree.
- Enter data.
- Review data periodically, especially to ensure that all records are attaching to the right trees.
  - If you failed to select a tree when creating a Condition or Work record, the record will be attached to the previous tree you were working on – edit the TreeID# in the record to attach it to the right tree.
  - If you duplicated a TreeID number and created a record on it, the record will be attached to the first tree that had that ID number. Edit the tree static record of the second tree to change the ID number, then use the Search function to find the first tree. Edit the TreeID# in the Condition or Work Record that mistakenly got attached to this tree to move it to the right tree.

On return to office:

Review data in ArcGIS Online or ArcMap. Check tree locations against imagery. Review data and check for errors and omissions. Fix or note any discrepancies.

City of Falls Church Tree Inventory Field Reminders

PRINT DOUBLE-SIDED WITH DBH DIAGRAMS

Health

Use the Condition Note field to describe observations leading to a "Fair" or "Poor" rating.

- Good = tree appears to be in good health. No evidence of stress, pests (insects or vines), disease or decay.
- Fair = tree shows some signs of stress, pests, disease or decay, but intervention does not appear to be necessary.
- Poor = tree shows signs of significant stress, pests, disease or decay. In the absence of intervention, the tree's health is likely to decline.
- Dead = the tree appears to be completely dead.
- [Blank] = do not enter a value if no health assessment was made.

Structure

Use the Condition Note field to describe observations leading to a "Fair", "Poor" or "Compromised" rating.

- Good = the tree's structure appears to be sound: roots are secure and uncompromised; root crown is above grade; trunk is vertical or has appropriate reaction wood if leaning; trunk is appropriately tapered and shows no significant cracks or damage; branch structure is balanced and major branch attachments are well-angled and free of included bark.
- Fair = the tree's structure is sound but may deteriorate with time or could be improved with intervention where appropriate. For example, roots are damaged or the root crown is buried; trunk wood is missing due to damage or decay, but not enough to affect stability; large branches have broken but are stable; branch structure is not well balanced or has some attachments which appear to be weak.
- Poor = the tree's structure is poor and is likely to deteriorate without intervention. For example, roots are exposed by erosion, severely damaged or heavily girdled; trunk is severely damaged or is cracked but appears to be stable; tree has been topped or is heavily imbalanced; the tree has codominant leaders or major branch junctions with significant included bark.
- Compromised = the tree's structure is poor and is clearly deteriorating.
- [Blank]= do not enter a value if no structural assessment was made.

Age Class (based on the tree size, species and condition)

- Seedling or newly planted = 1-2 yrs in location, not yet established.
- Juvenile = established and growing rapidly, but has not yet developed its full complement of scaffold and secondary branches.
- Young = fully established and should be growing rapidly. Structure is largely developed. Has not reached the mature size expected for the species (bearing in mind the limitations imposed by the planting location).
- Mature = Growth is moderate to slow, flower and seed production is established (if appropriate), and some self-pruning may be evident.
- Post-mature = shows signs of aging such as branch dieback, intolerance to disturbance and slow growth.

Mulch
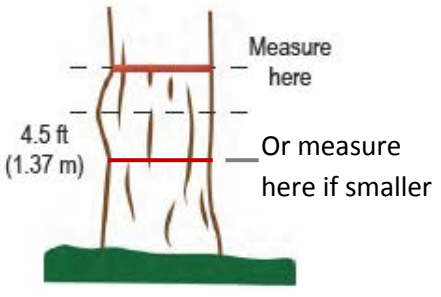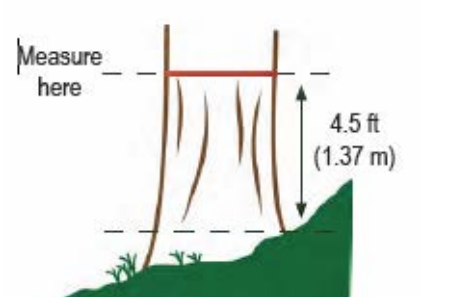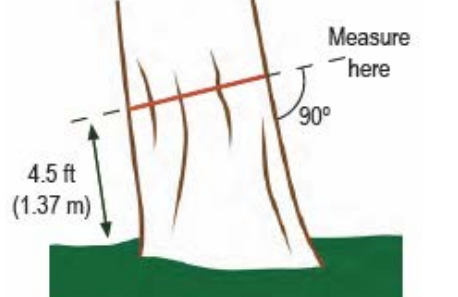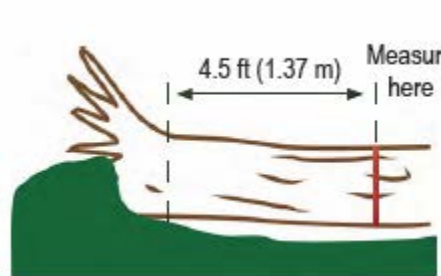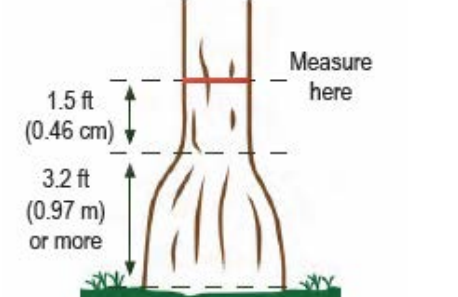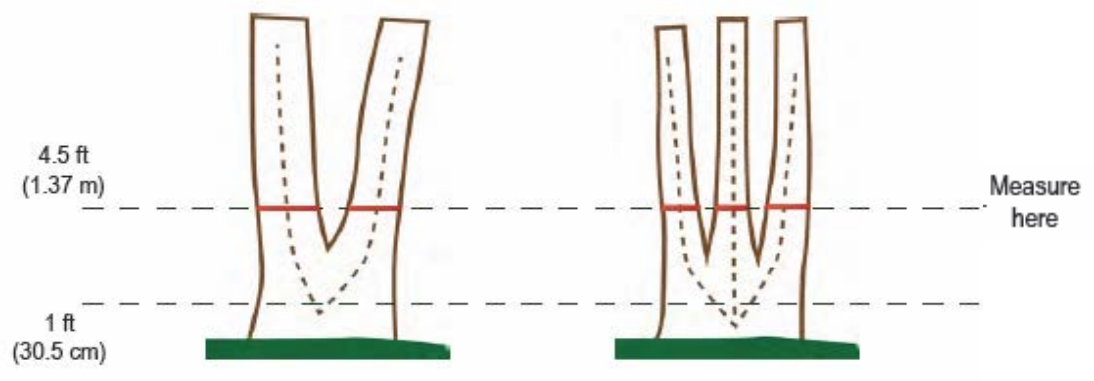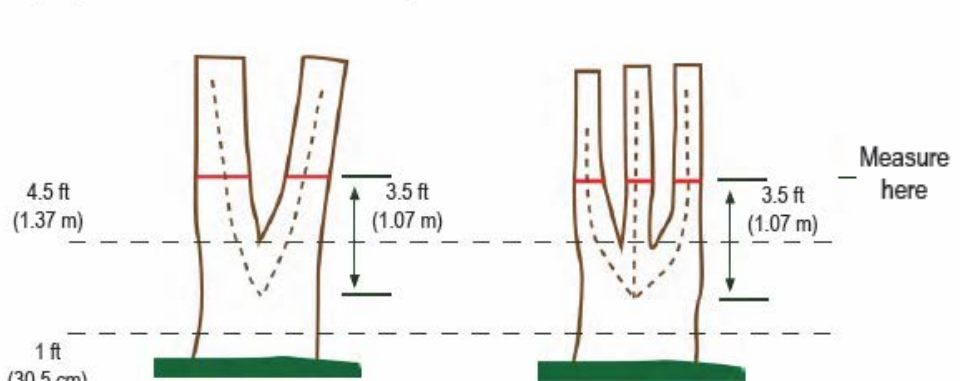
- Excess = mulch exceeds 3" deep and/or touches trunk.
- Good = mulch is 2"-3" deep, at least 3" from trunk and extends to 3' from trunk (or full extent possible where space is limited).
- Low = additional mulch would be beneficial and can be applied.
- None= site limitations prevent mulching.
- [blank] = not assessed

Conditions

- *Severe = potential safety issue*
- *Significant = needs to be addressed*
- *Insignificant = monitor*
- *[blank]= not present or not assessed*

Reassessment/Action

- *1 wk – potential safety issue or tree health severely compromised.*
- *6 mo – seedling or newly-planted tree, or older tree with conditions indicating intervention is likely to be needed.*
- *1 yr – juvenile tree, or older tree with conditions indicating intervention may be needed.*
- *2 yrs – young tree, or older tree with conditions that need to be monitored.*
- *5 yrs – mature or post-mature tree, no conditions indicating intervention will be needed.*

Bump or branch on trunk	Tree on sloping ground	Leaning tree
Measure here 4.5 ft (1.37 m) Or measure here if smaller	Measure here 4.5 ft (1.37 m)	Measure here 90° 4.5 ft (1.37 m)

Windthrown tree	Butt swell	
4.5 ft (1.37 m) Measure here	Measure here 1.5 ft (0.46 cm) 3.2 ft (0.97 m) or more	

Multistem trees

When the piths intersect below 1 ft, measure DBH for each stem at 4.5 ft above the ground.

4.5 ft (1.37 m)

1 ft (30.5 cm)

Measure here

When the piths intersect between 1 ft and 4.5 ft, measure the DBH of each stem 3.5 ft above the pith intersection (or as high up as is feasible for the field crew to reach).
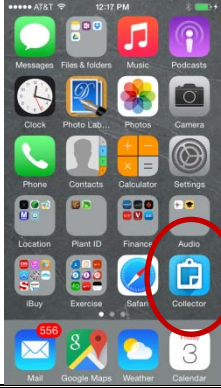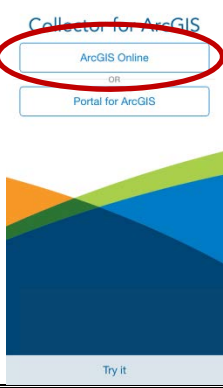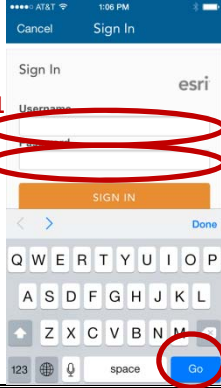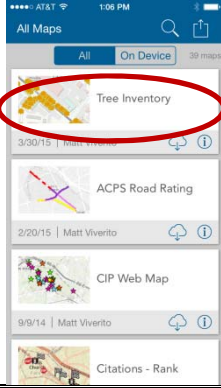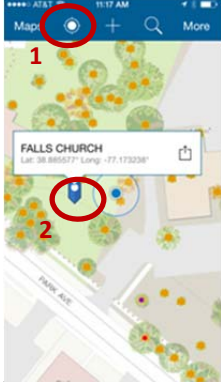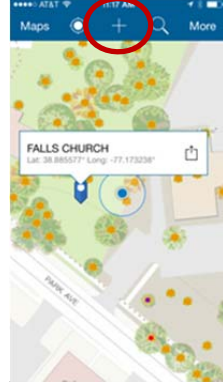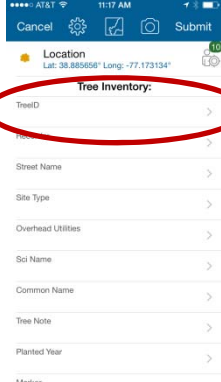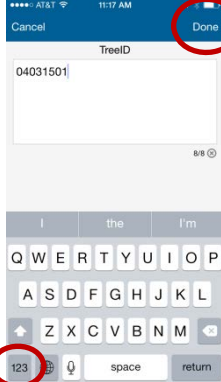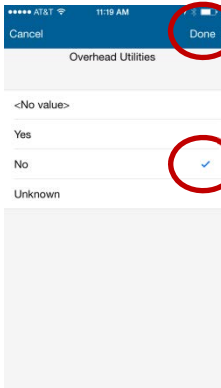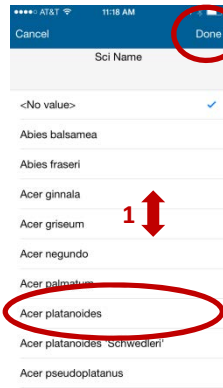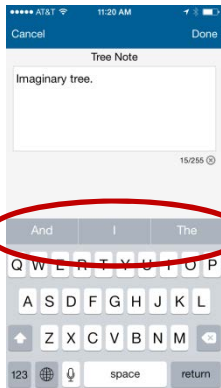
4.5 ft (1.37 m)

3.5 ft (1.07 m)

1 ft (30.5 cm)

3.5 ft (1.07 m)

Measure here

CITY OF FALLS CHURCH TREE INVENTORY

iPHONE INSTRUCTIONS

APRIL 5, 2015

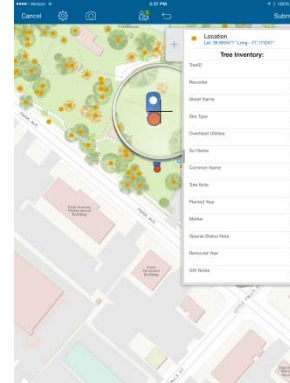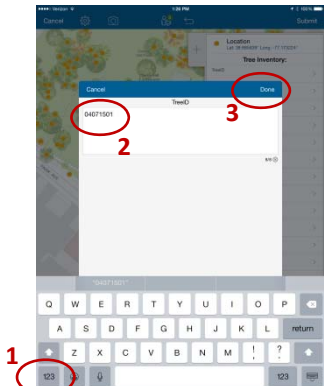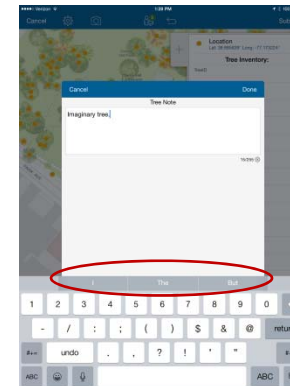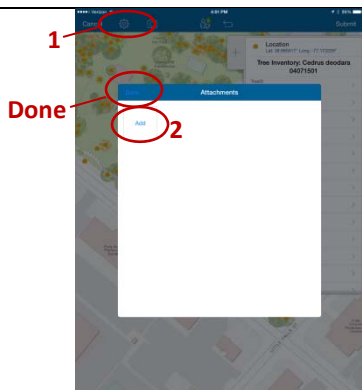| **1.** Open Collector App.	**2.** Touch "ArcGIS Online".	**3.** Touch in Username field and type, then touch in Password field and type. Then touch "Go".	**4.** Choose the "Tree Inventory" map.
5. Touch the ⊙ icon. A blue dot shows where you are. Touch where the tree is and a marker will pop up.	**6.** Touch the + sign. (If you need to make fine adjustments to the tree location, you can do it after data entry).	**7.** The data collection screen appears. Touch anywhere in a data-field line to enter data.	**8.** Tree ID – Touch "123" to use the number pad. Enter date (*mmddyy)* and a sequential number. Touch "Done".
9. Some fields have dropdown menus – touch to select, then touch "Done".	**10.** The Sci Name field has a long menu. Flick the screen to scroll, touch to stop. Touch again to select, then touch "Done".	**11.** Use predictive typing to make text entry faster and more accurate.	**12.** When data entry is complete, touch "Submit". Data will be added to the map live.

Operating the Collector App on the iPhone or iPad is very similar. See the iPad instructions for further details.

CITY OF FALLS CHURCH TREE INVENTORY

IPAD INSTRUCTIONS

APRIL 5, 2015

iPad: Add a Tree

1. Touch the icon to open the Collector App.	**2.** Touch "ArcGIS Online".	**3.** Touch in Username field and type, then touch in Password field and type. Then touch "SIGN IN".	**4.** Choose the "Tree Inventory" map.
5. Touch the ⊙ icon. A blue dot centers your location. Touch where the tree is and a marker will pop up. You can make fine adjustments to the tree location after you begin data collection.	**6.** Touch the ⬆ icon, then "Collect Here". Touch "Tree Inventory" and the data collection menu will appear.	**7.** If you need to adjust the tree position, touch and hold the red dot. A magnifier and crosshairs appear for precise repositioning. Let go when done.	**8.** Touch anywhere in a data-field line to enter data.
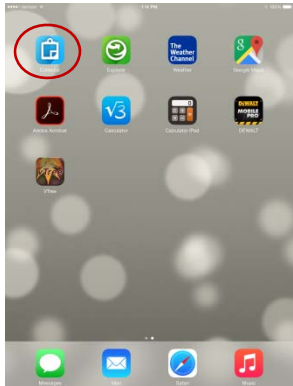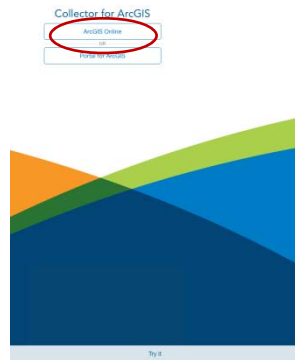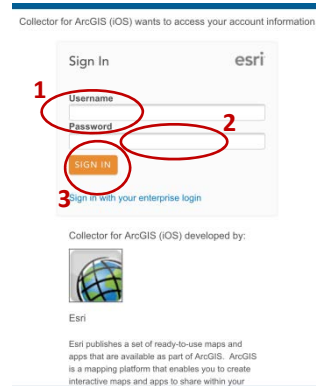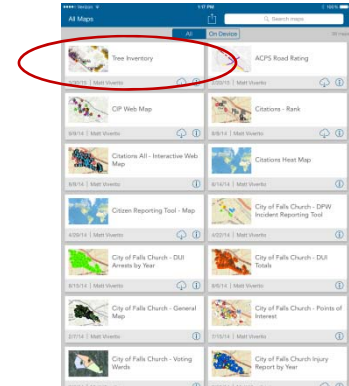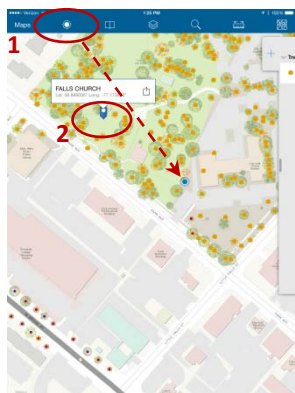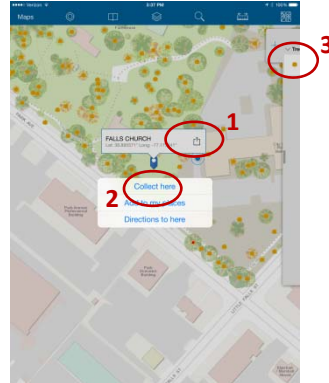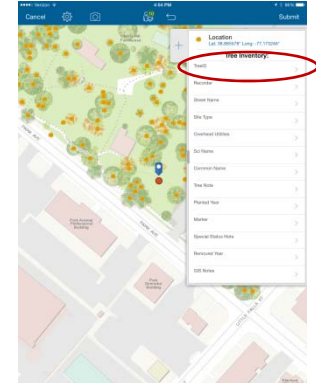
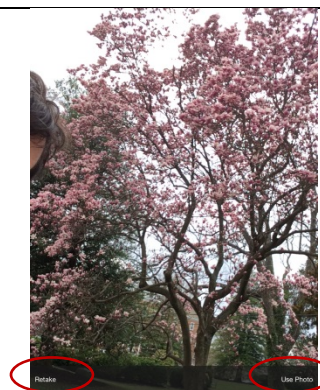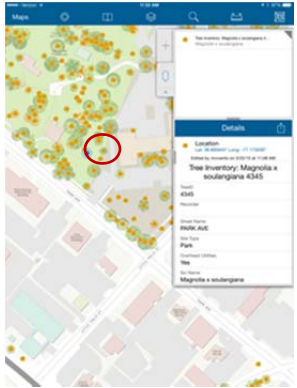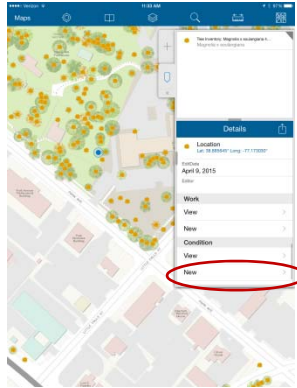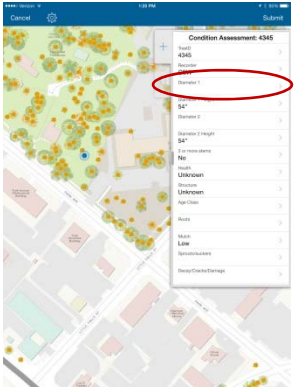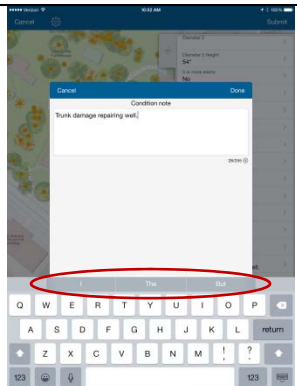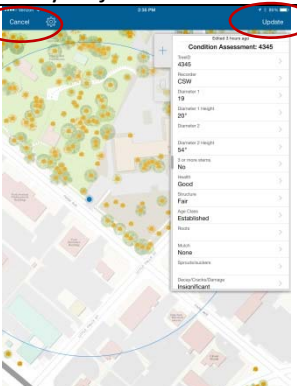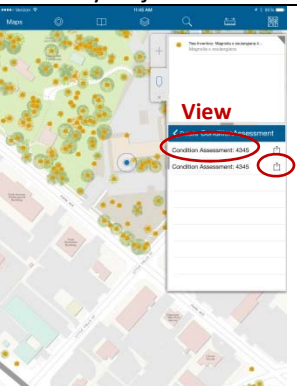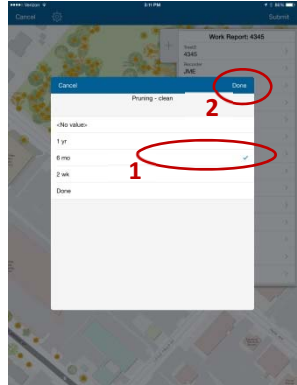| **9.** Tree ID – Touch "123" to use the number pad. Enter date (*mmddyy)* and a sequential number. Touch "Done". If the number is a duplicate, records will be on the first tree.	**10.** Some fields have dropdown menus – touch to choose your rating, then touch "Done".	**11.** The Sci Name field has a long menu. Flick to scroll, touch to stop. Touch again to select, then touch "Done".	**12.** Use predictive typing to make text entry faster and more accurate. Do not abbreviate.
13. To add a photograph, touch the camera icon, then touch "Add". Touch "Take Photo or Video".	**14.** To take a photo without removing the iPad case, touch ⬚ to use the front lens. The white button clicks the shutter.	**15.** Touch "Use Photo or Retake", then "Add" another picture or touch "Done" (step 13).	**16.** When data entry is complete, touch "Submit". Data will be added to the map live. "Cancel" will erase all of the data you just entered.
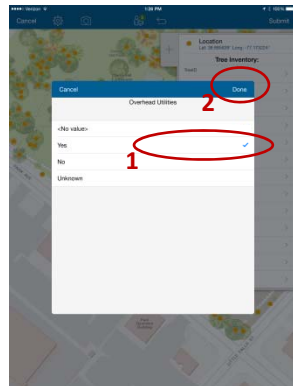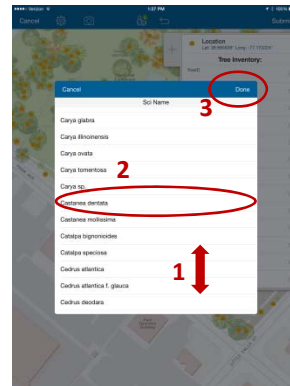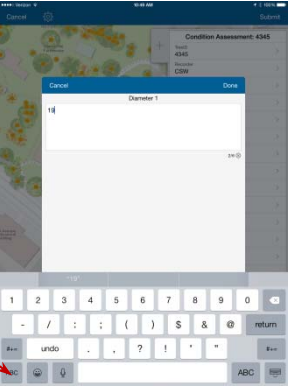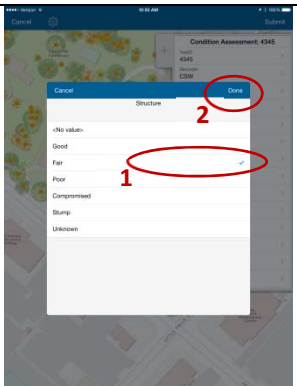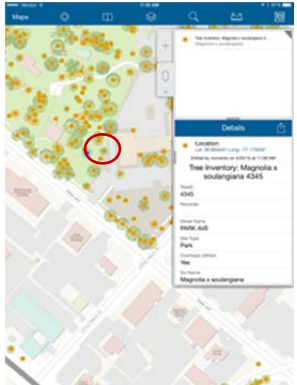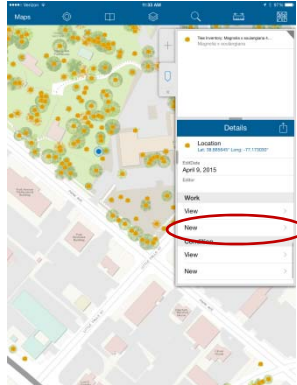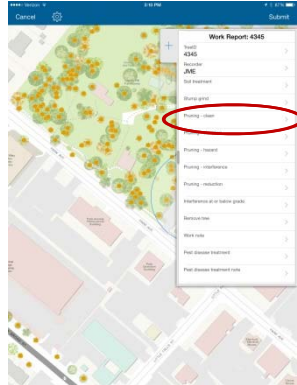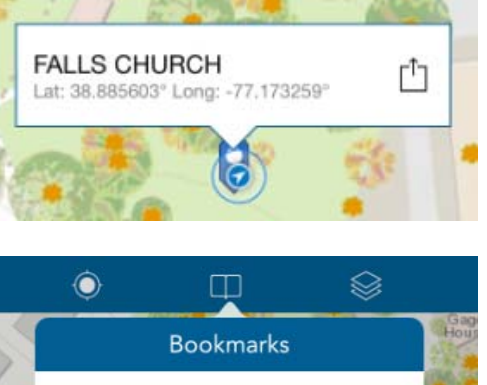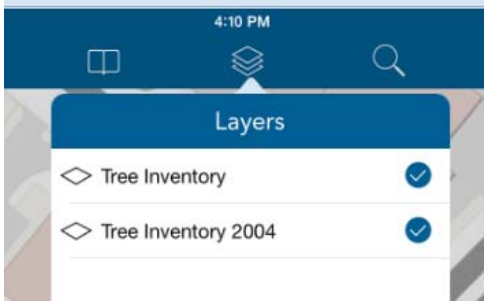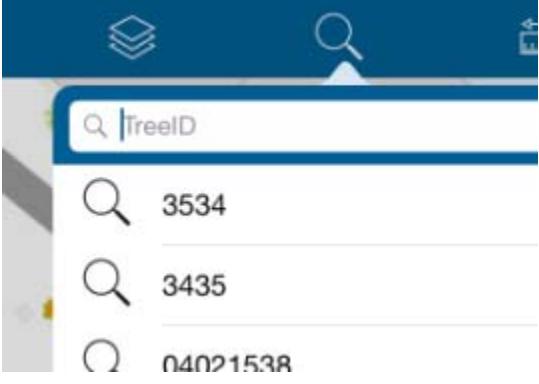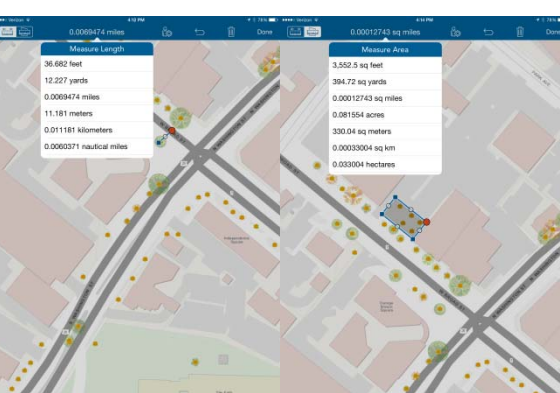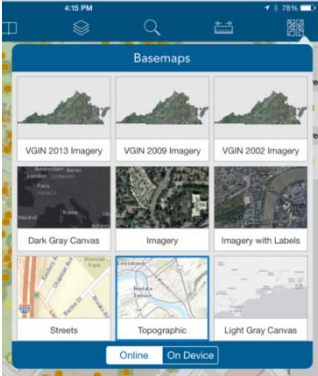
1. Touch to highlight the tree you want to add a record to. **NOTE:** If you just entered a new tree, you *must* touch it, or your record will be associated with the *previous* tree you selected.	**2.** Scroll down the tree record to the bottom. Select "New" from the Condition options.	**3.** Touch anywhere in a data-field line to enter data. To add a photograph, finish the Condition record first, then touch 📤 in the Details bar to edit the *Tree* record (steps 13 to 15 in "Add a Tree").	**4.** Numeric data: touch "123" to use the number pad. Enter the information. Touch "Done".
5. Some fields have dropdown menus – touch in the field to select, then touch "Done".	**6.** Use predictive typing to make text entry faster and more accurate. Do not abbreviate.	**7.** When data entry is complete, touch "Submit". Data will be added to the map live. "Cancel" will erase all of the data you just entered.	**8.** Records are listed with the oldest at the top. Touch the words to view a record. Touch the 📤 icon then "Edit" to edit a record you just created.

iPad: View/Add a Work Record

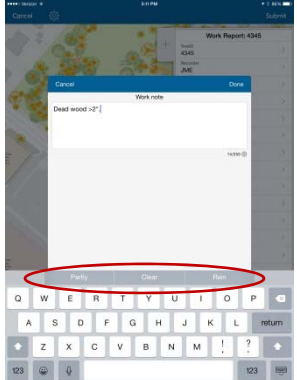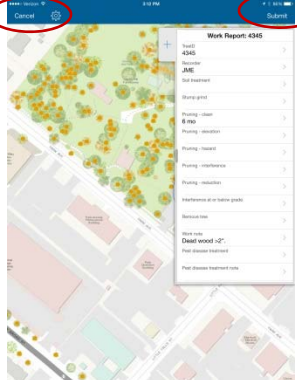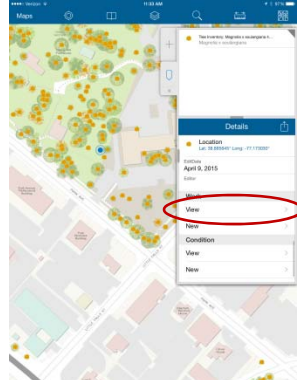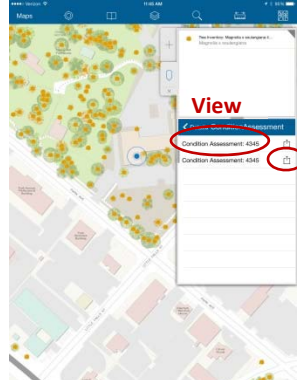|			
1. Touch to highlight the tree you want to add a record to. **NOTE:** If you just entered a new tree, you must touch it, or your record will be associated with the *previous* tree you selected.	**2.** Scroll down the tree record to the bottom. Select "New" from the Work options.	**3.** Touch anywhere in a data-field line to enter data.	**4.** Most fields have dropdown menus – touch in the field to select, then touch "Done".
5. Use predictive typing to make text entry faster and more accurate. Do not abbreviate.	**6.** When data entry is complete, touch "Submit". Data will be added to the map live. "Cancel" will erase all of the data you just entered.	**7.** When you submit data, you are returned to the Tree record. Select View in the Work or Condition records to view all records for the tree.	**8.** Records are listed with the oldest at the top. Touch the words to view a record. Touch the icon then "Edit" to edit a record you just created.

COLLECTOR APP GENERAL INSTRUCTIONS

Locator button Touch to toggle.	Bookmarks When you select a location, you can save it to Bookmarks using the Edit button ⬆ and find it again using the Bookmarks button 📖 .	Layers You can display multiple layers (but be aware that this can make the map load very slowly).
◎ Your location is centered on the screen. ◎ Your location is not shown. ◎ Your location is off-screen.	FALLS CHURCH Lat: 38.885603° Long: -77.173259° Bookmarks	4:10 PM Layers ◇ Tree Inventory ✓ ◇ Tree Inventory 2004 ✓
Search by feature (TreeID) You can search for Trees by their ID number. This can be very helpful if you accidentally move a tree or attach a record to the wrong one.	**Measure** Touch 📏 to measure distances or areas.	**Layers** Touch ▦ to access other basemaps. Zoom may be limited. "Topographic" seems to work best now.
Q TreeID Q 3534 Q 3435 Q 04021538	Measure Length 36.682 feet 12.227 yards 0.0069474 miles 11.181 meters 0.011181 kilometers 0.0060371 nautical miles Measure Area 3,552.5 sq feet 394.72 sq yards 0.00012743 sq miles 0.081554 acres 330.04 sq meters 0.00033004 sq km 0.033004 hectares	Basemaps VGIN 2013 Imagery, VGIN 2009 Imagery, VGIN 2002 Imagery Dark Gray Canvas, Imagery, Imagery with Labels Streets, Topographic, Light Gray Canvas Online On Device

iPad General Instructions

If touching the screen doesn't select things:

1) Make sure the screen is clean and dry.
2) Move the things you were looking at off the screen, then move back to refresh the image.
3) Click the Home button once, then touch the app icon to return to the app.
4) If you know the TreeID, use the search feature.
5) Return to step 1. DO NOT THROW THE IPAD.

If things aren't displaying as you expect in Collector:

1) Wait…several minutes.
2) Move the things you were looking at off the screen, wait, then move back to refresh the image.
3) Click the Home button once, wait for the screen to shift, then touch the app icon to return to the app.
4) Double click the Home button and flip the app off the top of the screen. Click the Home button again, reopen the app (new login not required).
5) Sign out of the app and sign back in.
6) Sign out of the app, double click the home button, flip the app off the top of the screen. Click the home button again, reopen the app, and sign back in.
7) Sign out of the app, double click the home button, flip the app off the top of the screen. Press and hold the Sleep/Wake button to power the device off. Wait, then press and hold again to power back on. Reopen the app.
8) Return to step 1. DO NOT THROW THE IPAD.

City of Falls Church 2015 Tree Inventory Data Descriptions

STATIC RECORD	
The "static" record for each tree contains information which does not routinely change. Field data will typically only be collected once. Some data require access to city records.	
Field	**Data description**
Tree ID #	A unique identification number, linked to the GIS Object ID, assigned when a new tree record is created. This number links all records associated with this individual tree. **Tree records are not to be deleted!** When a new tree is added to the inventory, a temporary ID number must be created in the field. Failure to create a Tree ID number will result in disassociation of Condition and Work records from the tree data. When a tree is removed by felling, fill in the work record "Stump Grind", if needed. When a tree and stump are both gone, fill in the "Removed Year" field. This removes the tree from queries of existing trees without deleting its records altogether. If a tree is transplanted, the tree object can be moved on a computer-displayed ArcGIS map, and a note added to the "Tree Note" field to indicate that the GPS coordinates have been changed.
Recorder	Select the initials of the person recording the data. The full names of personnel entering data are stored in the database.
GPS Coordinates	GPS coordinates of trees inventoried in 2004 were imported into the database. GPS coordinates of new trees are automatically entered by the collection device when the tree record is created. Post-collection processing of tree locations to match satellite imagery in ArcGIS may be used to correct GPS errors if necessary.
Street (or Site) Name	This information can be displayed as a layer on the map during data collection. In the database, it has been prepopulated for the data from the 2004 inventory. As new trees are entered, the database will need to be manually processed to add the information from the City's maps.
Address #	This information can be displayed on the map during data collection. In the database, it has been prepopulated for the data from the 2004 inventory. As new trees are entered, the database will need to be manually processed to add the information from the City's maps.

Site Type	Select the type of site where the tree is located: Street/Park/ Other City Facility/School/Commercial/Residential/ Unknown.
	 Street trees are identified functionally; a tree is a street tree if it is
	   − in the right of way;
	   − within 15' of the street edge if the location of the right of way is not known;
	   − in a street use easement, or
	   − overhanging the road or sidewalk on the street-front of a park.

City of Falls Church 2015 Tree Inventory Data Descriptions

STATIC RECORD	
The "static" record for each tree contains information which does not routinely change. Field data will typically only be collected once. Some data require access to city records.	
Field	**Data description**
Overhead Utilities	Select Y or N to indicate the presence or absence of overhead utilities (including power and phone lines, but not traffic control devices).
Scientific Name	Select the tree's scientific name (genus and species) from the dropdown list. Be as precise as possible. If you know the genus and species but they are not on the list, use the Tree Note field to record them. "[Genus] sp." may be used if the species cannot be determined. Species "Unknown broadleaf", "Unknown conifer" may be used if the genus is uncertain. "Unknown tree" should be used only when it is not possible to ascertain if the tree is a broadleaf or conifer. Trees identified as species "Stump" should also have a timeframe for "Stump grind" selected in the Work Record. Sites suitable for planting may be recorded as "planting space".
Tree Note	Note permanent characteristics of the tree or changes made to the permanent record such as correction of species, removal of utility lines, change of site type, etc. Keep notes as short as possible without abbreviation.
Planted Year	The four-digit year in which the tree was planted. The data will be entered as the tree is planted. If the actual planting date is unavailable, an estimate (based on addition since the 2004 inventory and/or tree size) may be entered.
Plant Type	Select the type of stock planted: B&B (balled & burlapped)/Container/Bare Root/Transplant/Self-set/Unknown. This information will usually be entered as the tree is planted.
Planted By	Select who planted the tree: City/Neighborhood TP/Private/ Other/Unknown/. This information will usually be entered as the tree is planted.
Tree Owner	Select the tree ownership as determined by measurement and comparison to plats. ***DO NOT GUESS , ESTIMATE MEASURMENTS OR RELY ON GPS DATA ALONE!***
Maintenance Responsibility	In rare cases, the owner may not be the party responsible for maintaining the tree. Check city records for this information.
Maintenance Agreement	If the owner is not the party responsible for maintaining the tree, there may be a maintenance agreement establishing who is. Check city records for this information.
Specimen	Enter the four-digit year in which the tree is (or was) designated as a specimen. Check city records to determine if the tree was designated as a specimen tree in the past.
Honorary	A text field. Enter the name of the person honored and other relevant information. City or VPIS records should be consulted to determine if the tree was designated as an honorary tree in the past.

City of Falls Church 2015 Tree Inventory Data Descriptions

STATIC RECORD	
The "static" record for each tree contains information which does not routinely change. Field data will typically only be collected once. Some data require access to city records.	
Field	**Data description**
VPIS Designation	Select the type of designation assigned by VPIS: Memorial/Historic/Noteworthy.
Donation	A text field. Enter the donor name and other relevant information. Keep notes as short as possible without abbreviation.
Marker	Enter the marker type & text (e.g. 'Metal plaque on stone: "In Memory of Mary Smith 1996"' or 'Metal label on trunk: "Black Walnut VPIS Noteworthy Tree"'. Attach engineering drawing or photo of marker if available. Keep notes as short as possible without abbreviation.
Special Status Note	Note any additional information about special status. Keep notes as short as possible without abbreviation.
Removed Year	Enter the four-digit year in which the tree is removed (unless transplanted – see Tree ID # description). Trees removed between the 2004 and 2015 inventories should be recorded as removed in 2005 unless the removal date is known.

City of Falls Church 2015 Tree Inventory Data Descriptions

CONDITION RECORD	
The condition record for each tree contains observations of the tree's size, health, structure, age class and conditions relevant to health monitoring or maintenance needs. A new condition record is created each time a tree is inspected. Unless otherwise noted, observations and ratings are based on a brief visual scan of the tree. These condition ratings are not intended to be a rigorous or complete assessment of the tree's condition. They rely on the judgment of the inspector and are intended to identify needs for future monitoring or more detailed assessment. Photographs may be attached to the tree record to document conditions that should be monitored.	
Field	**Data description**
Tree ID #	The unique identification number of the tree, linked to the GIS Object ID, assigned when a new tree record is created. This number links all records associated with the individual tree. If you have just added a new tree to the inventory and are ready to collect Condition data, you must be sure the tree has an identification number, and you must actively select the new tree before creating the Condition record. If you enter data for a tree without a Tree ID number, it will not remain associated with the tree. If you do not actively select the new tree, data will be assigned to the previous tree inventoried.
Recorder	Select the initials of the person recording the data.
Diameter 1	The diameter of the largest stem of the tree, measured to the nearest 0.5" at 4'6" above grade, or in accordance with the DBH protocols attached as Appendix 1.
Diameter 1height	The height above grade at which the diameter of the largest stem of the tree was measured.
Diameter 2	For trees with two or more stems, the diameter of the second largest stem of the tree, measured to the nearest 0.5" at 4'6" above grade, or in accordance with the DBH protocols attached as Appendix 1.
Diameter 2height	For trees with two or more stems, the height above grade at which the diameter of the second largest stem of the tree was measured.
>2 stems?	Select Y (yes) or N (no) to indicate the presence or absence of more than 2 stems.
Health	Select the appropriate rating. Use the Condition Note field to describe observations leading to a "Fair" or "Poor" rating. • Good : tree appears to be in good health. No evidence of stress, pests (insects or vines), disease or decay. • Fair : tree shows some signs of stress, pests, disease or decay, but intervention does not appear to be necessary. • Poor: tree shows signs of significant stress, pests, disease or decay. In the absence of intervention, the tree's health is likely to decline. • Dead: the tree appears to be completely dead. • [Blank]: do not enter a value if no health assessment was made.

City of Falls Church 2015 Tree Inventory Data Descriptions

CONDITION RECORD	
The condition record for each tree contains observations of the tree's size, health, structure, age class and conditions relevant to health monitoring or maintenance needs. A new condition record is created each time a tree is inspected. Unless otherwise noted, observations and ratings are based on a brief visual scan of the tree. These condition ratings are not intended to be a rigorous or complete assessment of the tree's condition. They rely on the judgment of the inspector and are intended to identify needs for future monitoring or more detailed assessment. Photographs may be attached to the tree record to document conditions that should be monitored.	
Field	**Data description**
Structure	Select the appropriate rating. The conditions described are examples only, and are not intended to be an exhaustive list of factors impacting the structure rating. Use the Condition Note field to describe observations leading to a "Fair", "Poor" or "Compromised" rating. - Good: the tree's structure appears to be sound: roots are secure and uncompromised; root crown is above grade; trunk is vertical or has appropriate reaction wood if leaning; trunk is appropriately tapered and shows no significant cracks or damage; branch structure is balanced and major branch attachments are well-angled and free of included bark. - Fair: the tree's structure is sound but may deteriorate with time or could be improved with intervention where appropriate. For example, roots are damaged or the root crown is buried; trunk wood is missing due to damage or decay, but not enough to affect stability; large branches have broken but are stable; branch structure is not well balanced or has some attachments which appear to be weak. - Poor: the tree's structure is poor and is likely to deteriorate without intervention. For example, roots are exposed by erosion, severely damaged or heavily girdled; trunk is severely damaged or is cracked but appears to be stable; tree has been topped or is heavily imbalanced; the tree has codominant leaders or major branch junctions with significant included bark. - Compromised: the tree's structure is poor and is clearly deteriorating. [Blank]: do not enter a value if no structural assessment was made.

City of Falls Church 2015 Tree Inventory Data Descriptions

CONDITION RECORD
The condition record for each tree contains observations of the tree's size, health, structure, age class and conditions relevant to health monitoring or maintenance needs. A new condition record is created each time a tree is inspected. Unless otherwise noted, observations and ratings are based on a brief visual scan of the tree. These condition ratings are not intended to be a rigorous or complete assessment of the tree's condition. They rely on the judgment of the inspector and are intended to identify needs for future monitoring or more detailed assessment. Photographs may be attached to the tree record to document conditions that should be monitored.

Field	Data description
Age Class	Select the appropriate age class based on the tree size, species and condition. These classes are intended to be used as management categories, indicating the intensity of management required for maintenance of the tree in the landscape. • Juvenile: not fully established. Should be growing rapidly. May need seasonal watering. Has not yet developed its full complement of scaffold and secondary branches – structural pruning will probably be needed. • Established: fully established. Growth is moderate to slow. Structure is largely developed, and flower and seed production (if appropriate) is established. • Post-mature: shows signs of aging such as branch dieback, intolerance to disturbance and slow growth.
Roots	Select the appropriate rating of the condition as it relates to the health or structural integrity of the tree. Use the Condition Note field to describe the issue (such as girdling, damage, decay, erosion or undermining). • Severe • Significant • Insignificant • [blank]: not present or not assessed
Mulch	Select the appropriate rating. • Excess: mulch exceeds 3" deep and/or touches trunk. • Good: mulch is 2"-3" deep, at least 3" from trunk and extends to 3' from trunk (or full extent possible where space is limited). • Low: additional mulch would be beneficial and can be applied. • None: site limitations prevent mulching. • [blank]: not assessed

City of Falls Church 2015 Tree Inventory Data Descriptions

CONDITION RECORD	
The condition record for each tree contains observations of the tree's size, health, structure, age class and conditions relevant to health monitoring or maintenance needs. A new condition record is created each time a tree is inspected. Unless otherwise noted, observations and ratings are based on a brief visual scan of the tree. These condition ratings are not intended to be a rigorous or complete assessment of the tree's condition. They rely on the judgment of the inspector and are intended to identify needs for future monitoring or more detailed assessment. Photographs may be attached to the tree record to document conditions that should be monitored.	
Field	**Data description**
Sprouts/suckers	Select the appropriate rating. Use the Condition Note field to describe the issue. • Severe • Significant • Insignificant • [blank]: not present or not assessed
Decay/cracks/damage	Select the appropriate rating of the condition as it relates to the health or structural integrity of the tree. Use the Condition Note field to describe the issue. Create a Work Record if the rating is Severe <u>and</u> rapid response is needed (for example, to remove a recently broken limb that presents an immediate safety risk). • Severe • Significant • Insignificant • [blank]: not present or not assessed
Dead wood	Select the appropriate rating of the condition as it relates to the health or structural integrity of the tree. Use the Condition Note field to describe the issue. Create a Work Record if the rating is Severe <u>and</u> rapid response is needed (for example, to remove hanging dead wood that presents an immediate safety risk). • Severe • Significant • Insignificant • [blank]: not present or not assessed

City of Falls Church 2015 Tree Inventory Data Descriptions

CONDITION RECORD
The condition record for each tree contains observations of the tree's size, health, structure, age class and conditions relevant to health monitoring or maintenance needs. A new condition record is created each time a tree is inspected. Unless otherwise noted, observations and ratings are based on a brief visual scan of the tree. These condition ratings are not intended to be a rigorous or complete assessment of the tree's condition. They rely on the judgment of the inspector and are intended to identify needs for future monitoring or more detailed assessment. Photographs may be attached to the tree record to document conditions that should be monitored.

Field	Data description
Pests/disease	Includes animal/insect and plant pests. Select the appropriate rating of the condition as it relates to the health or structural integrity of the tree. Use the Condition Note field to describe the issue. • Severe • Significant • Insignificant • [blank]: not present or not assessed
Condition note	Note observations leading to ratings of less than good health or structure and conditions to be monitored or addressed. Note identity of pests/diseases if known. Keep notes as short as possible without abbreviation (for example "chlorosis", "codominant leaders", "root girdling", "trunk borer infestation (unidentified)").
Reassessment/Action	Select an appropriate timeframe for reassessment or action based on your observations. • 1 wk – potential safety issue or tree health severely compromised. • 6 mo – juvenile tree, or older tree with conditions indicating intervention is likely to be needed. • 1 yr – juvenile tree, or older tree with conditions indicating intervention may be needed. • 2 yrs – established or post-mature tree with conditions that need to be monitored. • 5 yrs – established or post-mature tree, no conditions indicating intervention will be needed.

City of Falls Church 2015 Tree Inventory Data Descriptions

WORK RECORD	
The work record for each tree contains information regarding work planned and performed on the tree. A new work record will be created when a tree is inspected only if specific work needs are identified. A new work record should always be created when work is done on the tree.	
Field	**Data description**
Tree ID #	The unique identification number of the tree, linked to the GIS Object ID, assigned when a new tree record is created. This number links all records associated with the individual tree. If you have just added a new tree to the inventory and are ready to collect Work data, you must be sure the tree has an identification number, and you must actively select the new tree before creating the Work record. *If you enter data for a tree without a Tree ID number, it will not remain associated with the tree. If you do not actively select the new tree, data will be assigned to the previous tree inventoried.*
Recorder	Select the initials of the person recording the data. With the current version of the Collector App, this must be done for each new work record.
Soil treatment	Leave blank if no work is needed. Select the appropriate time frame (1 yr/6 mo/1 wk) if work is needed, or select "done" when work has been done. Use the Work Note field to briefly describe the treatment applied e.g. mulch, decompaction, fertilization.
Stump grind	Leave blank if no work is needed. Select the appropriate time frame if work is needed (1 yr/6 mo/1 wk), or select "done" when work has been done. ***Remember, you must complete the "Removed Year" field in the tree's static record after grinding. If the space is appropriate for replanting, you should also create a new tree record with species "planting site".***
Interference at or below grade	Leave blank if no work is needed. Select the appropriate time frame if work is needed (1 yr/6 mo/1 wk), or select "done" when work has been done.
Pruning - clean	Remove dead, diseased or broken branches. Specify minimum size in work note. Use the Work Note field to describe any special needs or work done. Leave blank if no work is needed. Select the appropriate time frame if work is needed (1 yr/6 mo/1 wk), or select "done" when work has been done.
Pruning - elevation	Remove low branches to provide 7' clearance over grounds, 8' clearance over sidewalks and 14' clearance over roads. Use the Work Note field to describe any special needs or work done. Leave blank if no work is needed. Select the appropriate time frame if work is needed (1 yr/6 mo/1 wk), or select "done" when work has been done.
Pruning - hazard	Address hazardous condition. Use the Work Note field to describe the hazard and corrective action taken. Leave blank if no work is needed. Select the appropriate time frame if work is needed (1 yr/6 mo/1 wk), or select "done" when work has been done.