Exposure Metadata Flowcharts

ImageCat Inc.

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1.1 Level 1 – Global Exposure Data sets

The purpose of the exposure data needs to be clear, particularly for Level 1 data. For example, Level 1 data may be used only to estimate fatalities or population exposure to recent or hypothetical events, or it may be used to prioritize additional research. With Level 1 data, there will be

Population: The source of population data should be explicit for each country, along with an indication of quality and age.

If by admin level: The source of GIS boundaries and admin level, as well as the age.

If originally posted by grid: What is the source of the gridded data (i.e., WorldPop (WorldPop, 2018)), LandScan (Bright et al., 2016). In addition, the original source of population data should be provided covering the questions above, which should be available through the provider. Also provide scale, source, version, date of gridded population data, and methods of dasymetric mapping.

Structural distribution: Provide the source of data for each country, including bibliographic references of each source, and whether the data was available on a country-specific basis or was inferred from neighbouring countries (if so, which neighbouring country and source). Any adjustment for urban/rural or other factors needs to provide multiple distributions and acknowledge the source of adjustment with a bibliographic reference.

Number of buildings (if applicable): Number of buildings can either be directly inferred from remote sensing data or from global population data sets.

If inferred from population data, provide the method of inferring the number of people per household, the number of buildings per household, or the number of buildings per person. If there are adjustments for urban/rural areas, population density, or other factors these need to be explicitly stated and documented. Key values need to be provided for each country. If sampling was used, the method of sampling and the number of samples needs to be explicit.

If inferred from remote sensing data, provide the basic method of data extraction, base data layer, or source needs to be acknowledged. If inferred from an interpreted global remote sensing product (e.g., GHSL), the method of inferring the number of buildings from the provided product needs to be explicitly noted. If sampling was used, the method of sampling and the number of samples needs to be explicit.

If inferred from a combination of remote sensing data population data, the sources of each independent data set need to be acknowledged. Also, provide a complete description of the method of inference.

Building area (if applicable): The assumptions as to the building area by type of construction or by occupancy need to be provided. If sampling was used across multiple countries, then the method of sampling and the number of samples needs to be explicit. Also disclose if there were additional adjustments by other spatial data sets (such as urban/rural delineation), and the source of data and a bibliographic reference of the data used for adjustment.

Building height (if applicable): Assumptions as to the distribution of buildings by height range, if not captured by the structural type, need to be explicit. If sampling was used across multiple

countries, the method of sampling and number of samples need to be explicit. Disclose if there were additional adjustments by other spatial data sets (such as urban/rural delineation), as well as the source of data and a bibliographic reference of the data used for adjustment.

Replacement cost (if applicable): Estimates of replacement cost are generally provided based on the area of building stock by structural classification, or by occupancy. For Level 1, if included, estimates are likely to be based on GDP. Replacement cost can also be based on urban/rural delineations or other classifications from remote sensing data. Bibliographic references of all source data should be included, as well as the methods of assigning and scaling replacement costs for each country.

1.1.1 Level 1 – Flowcharts

Below is the Level 1 principle flowchart. The subsequent flowcharts give additional detail for each segment.

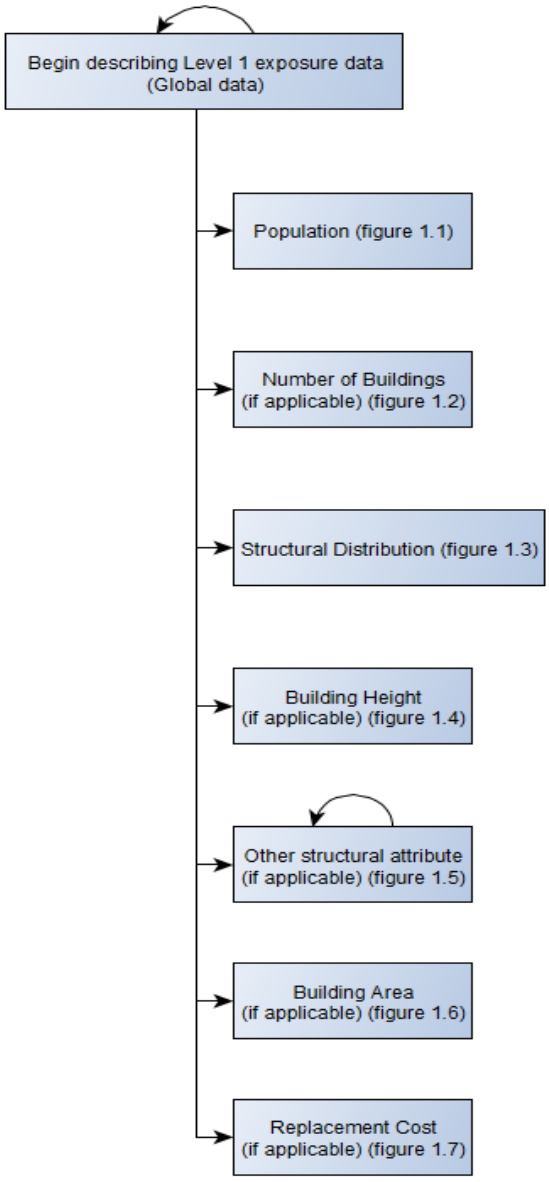

Figure 1.1.1: Principle Level-1 flow chart

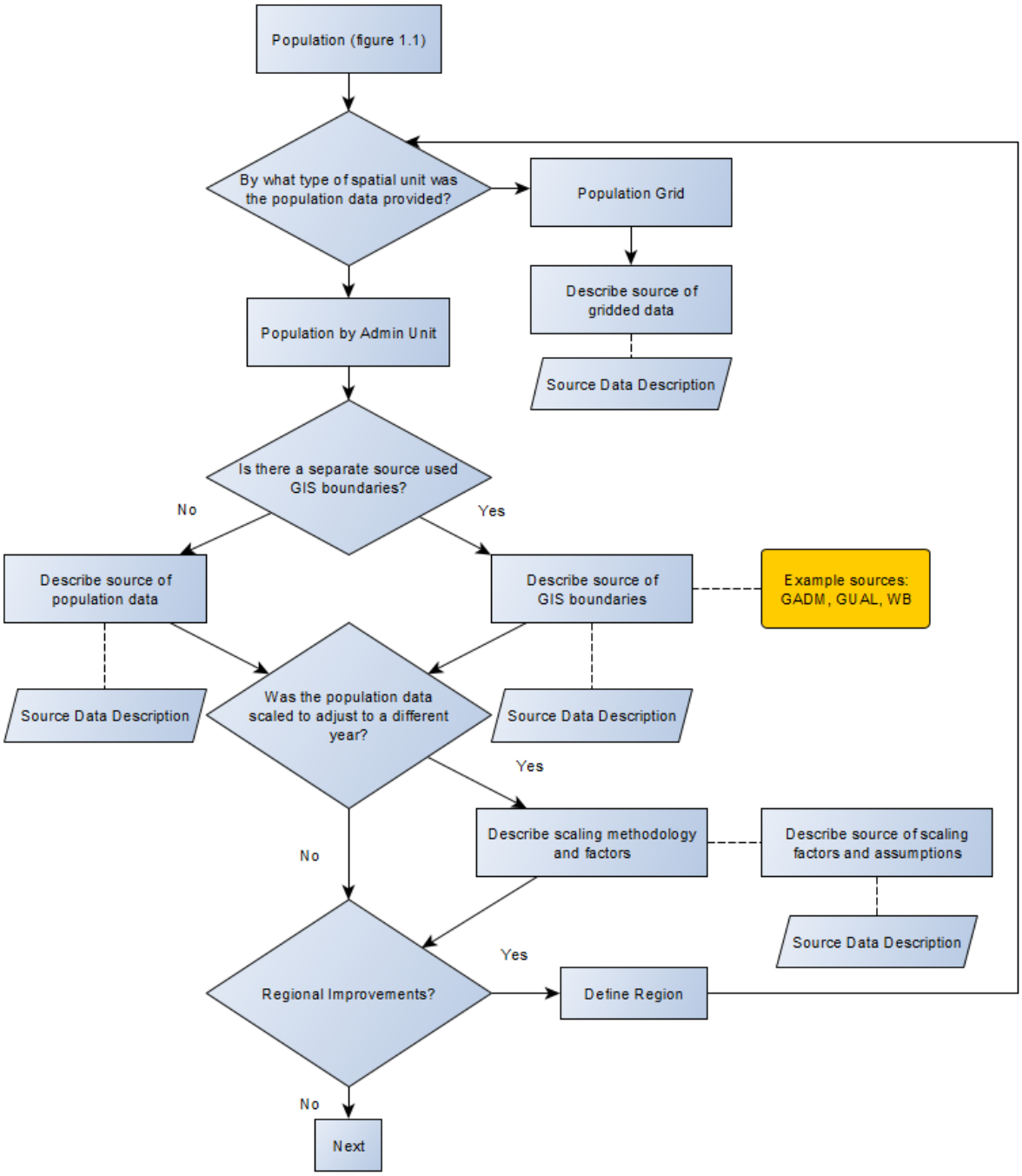

Figure 1.1.2: Method for determining population counts and obtaining useful information.

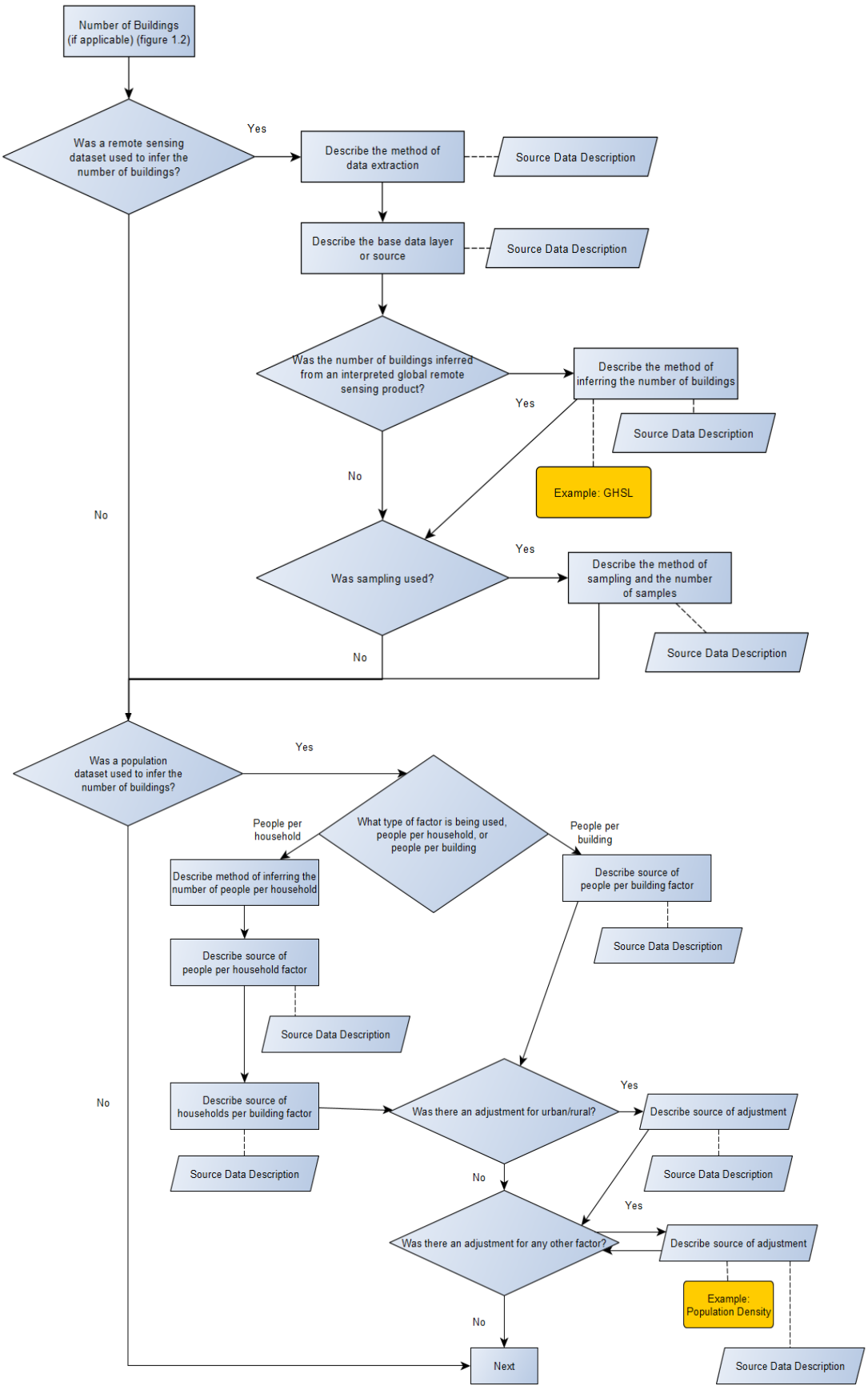

Figure 1.1.3: Flowchart for determining number of building counts.

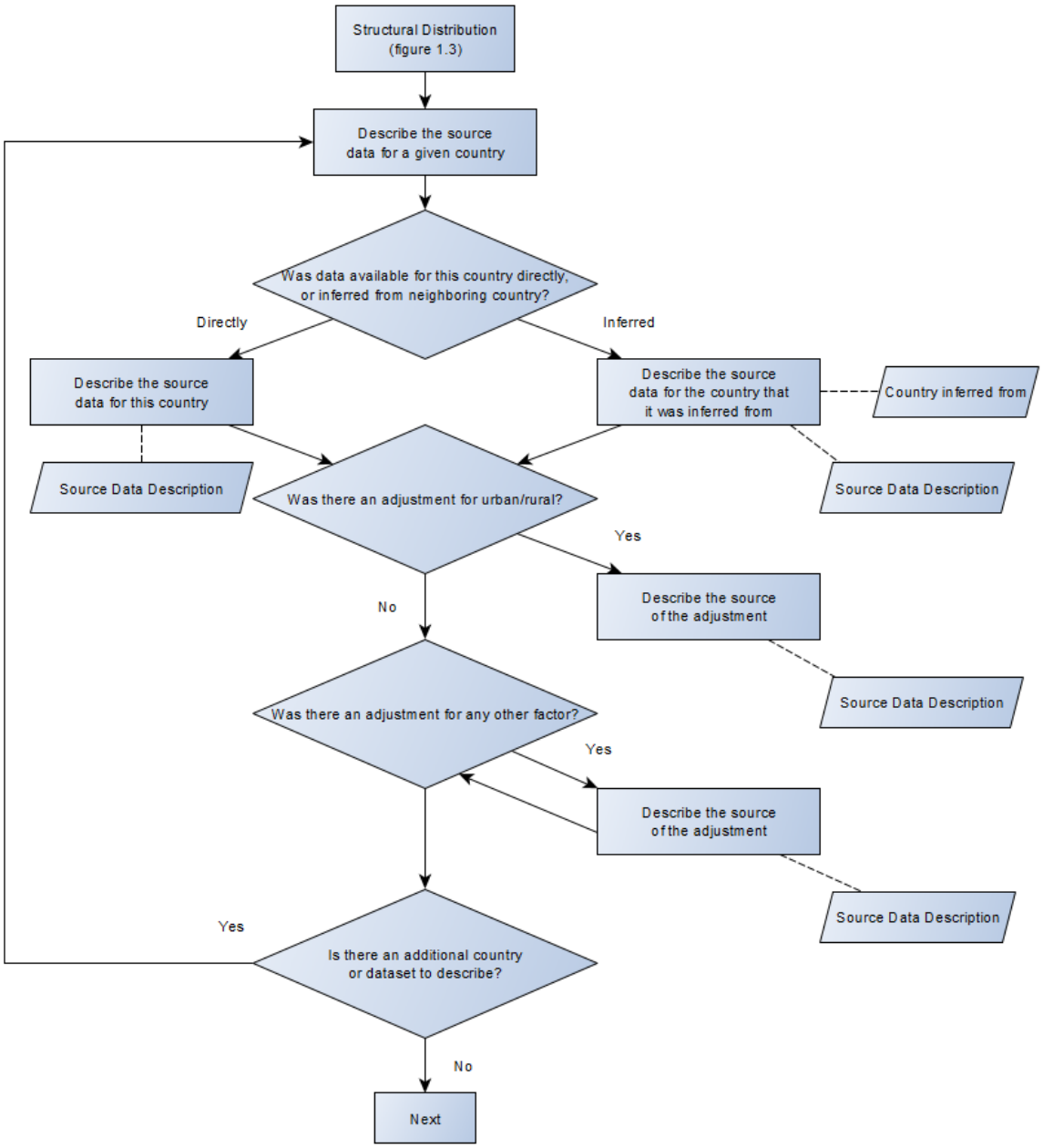

Figure 1.1.4: Flowchart displaying how to obtain a structural distribution value for the study.

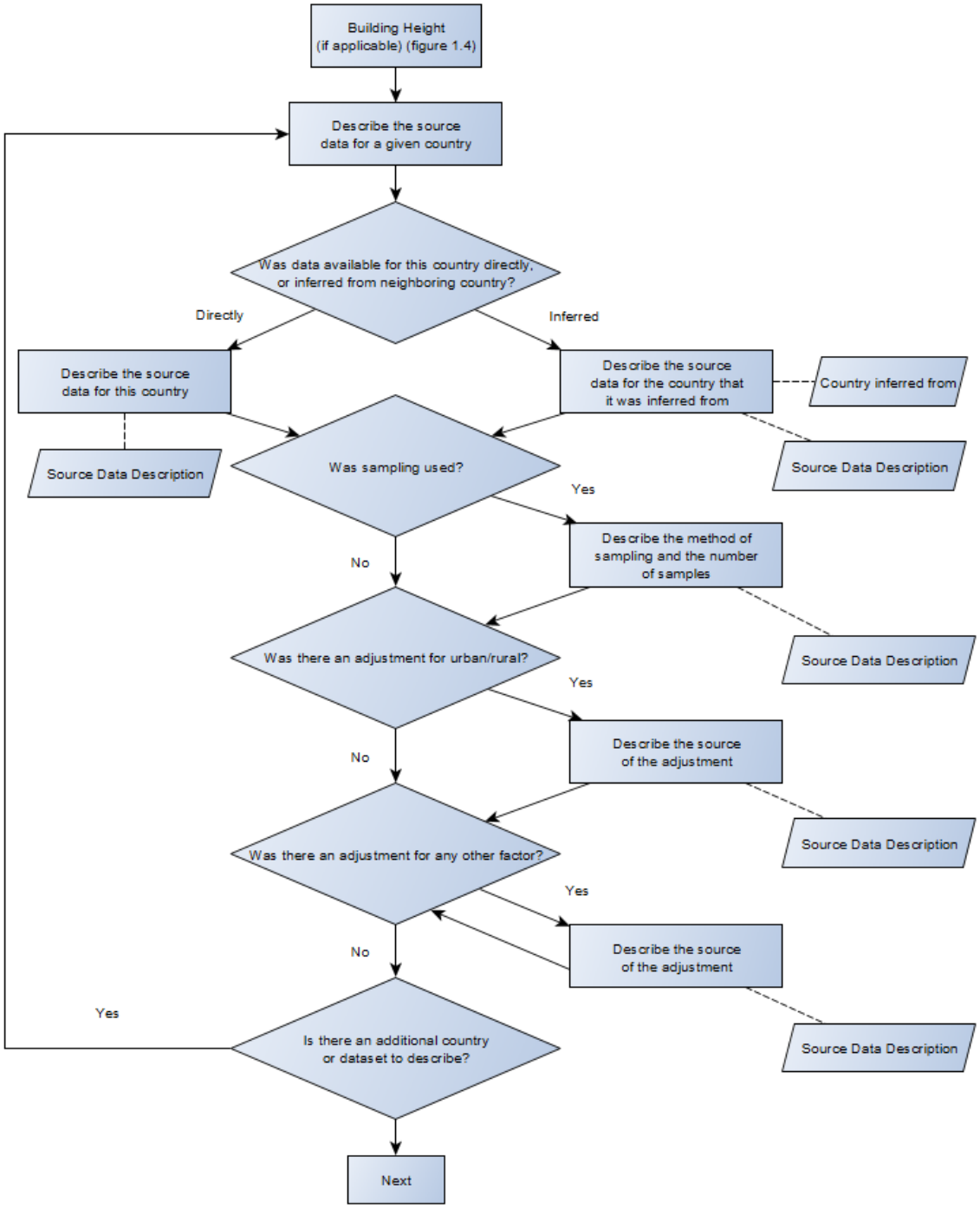

Figure 1.1.5: Flowchart for determining building height.

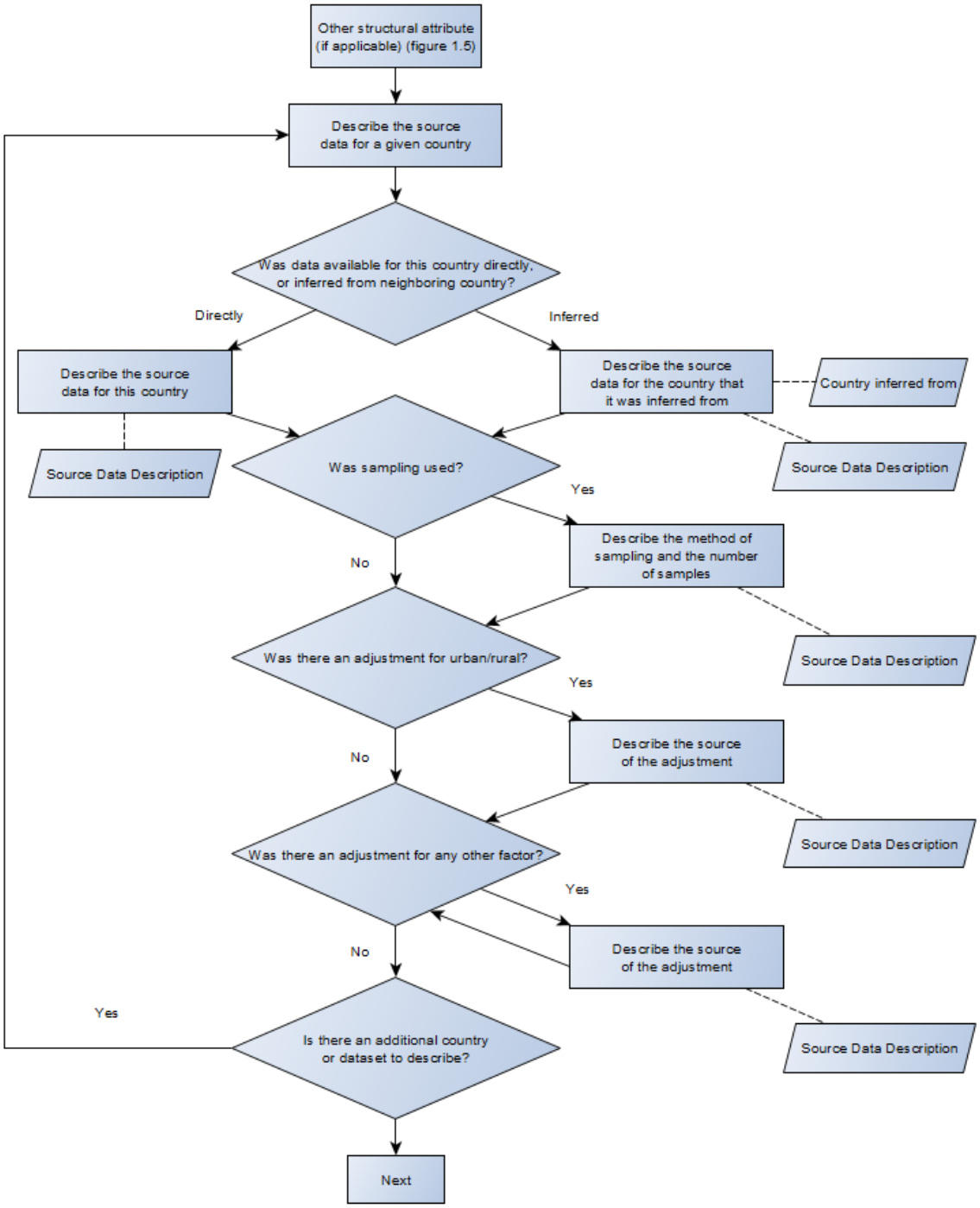

Figure 1.1.6: Flowchart example for additional structural attributes.

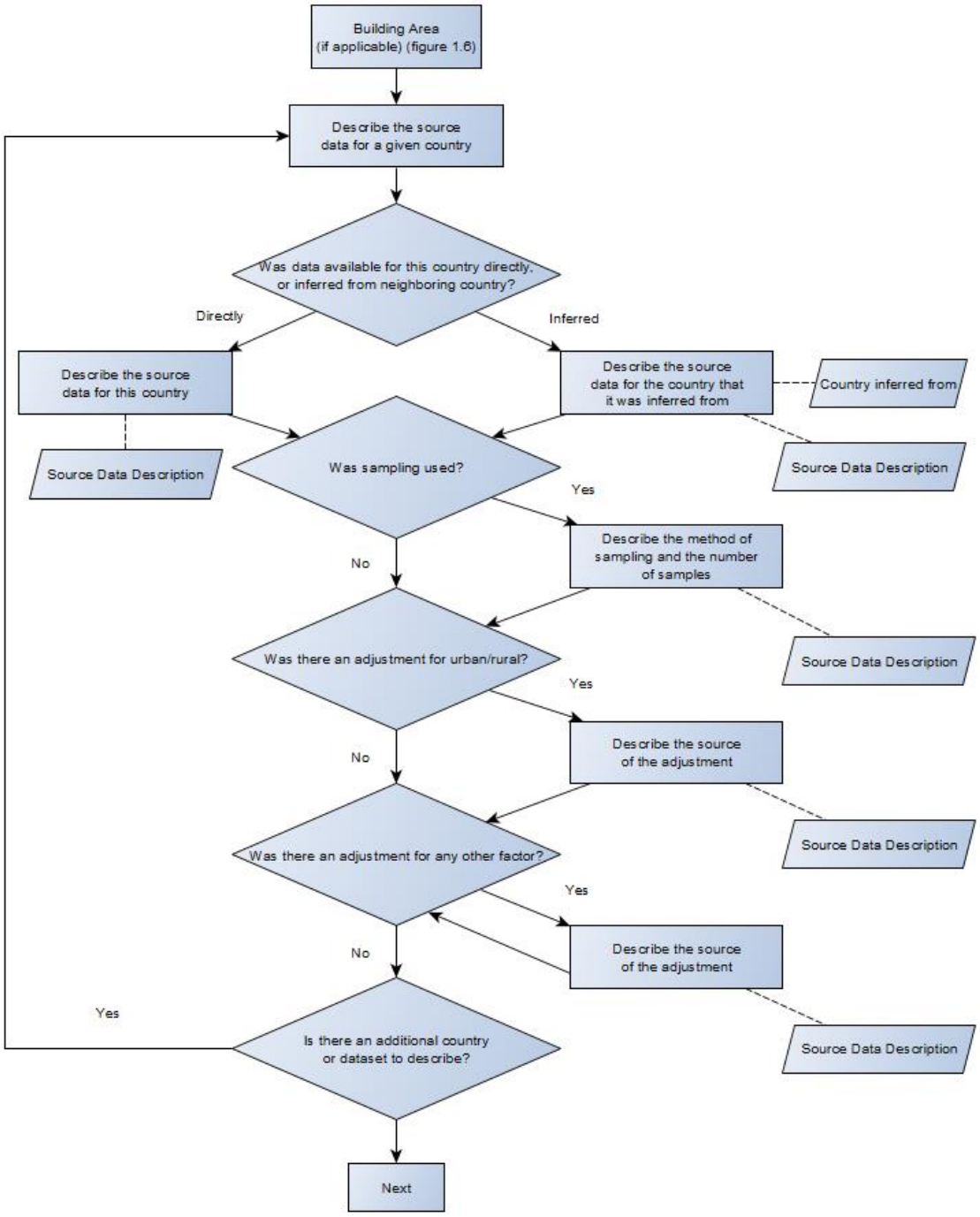

Figure 1.1.7: Flowchart for calculating building area.

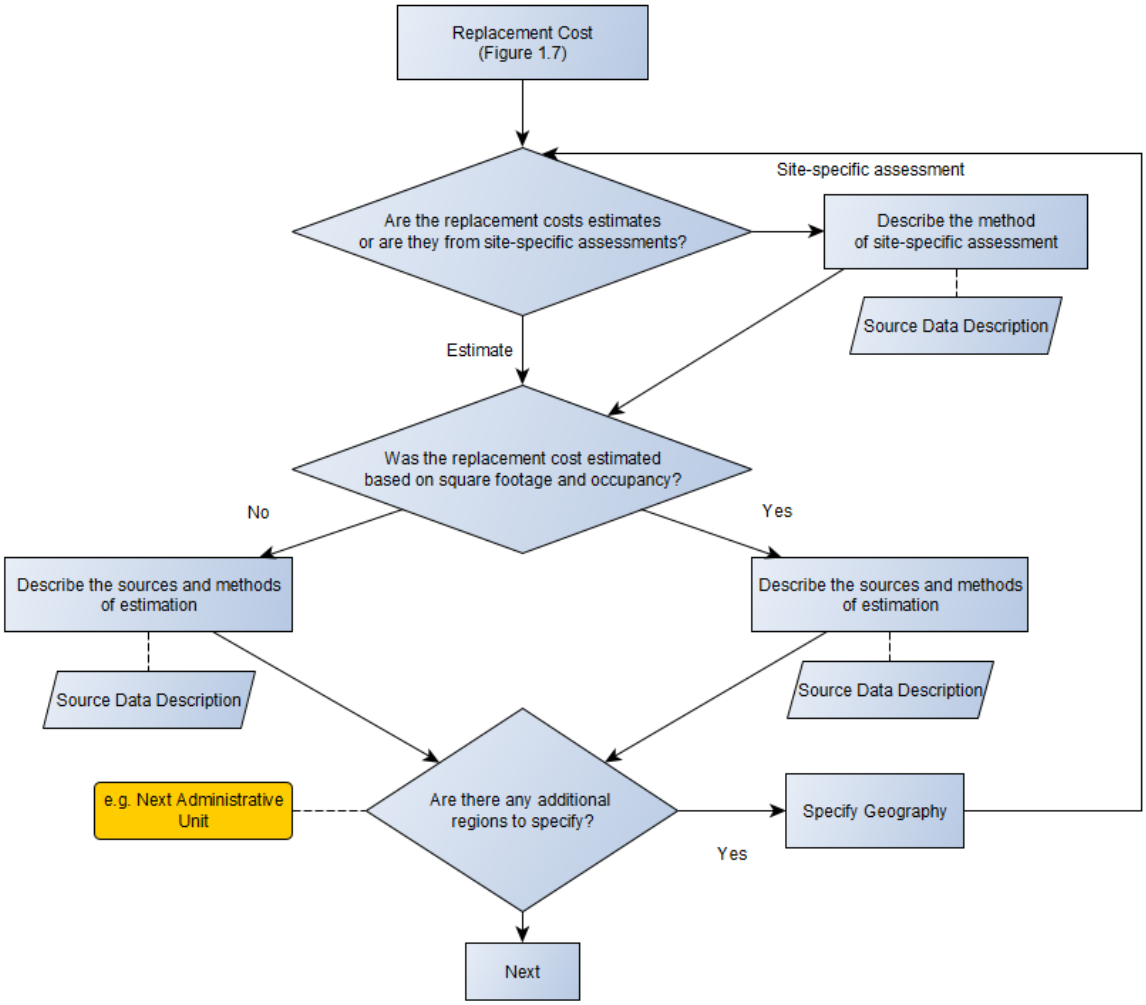

Figure 1.1.8: The flowchart displays the path for calculating replacement cost.

1.2 Level 2 – Country Specific Exposure Data sets

For Level 2 data, it is important to acknowledge all original sources of national scale and global data sets. For the overall data set, the geographic posting for the general building stock should be noted (e.g., admin unit, grid, variable resolution grid).

Population: The source of population data should be included with a bibliographic reference and link if applicable. If there has been scaling to adjust population to the current era, provide the factors used for scaling, how the scaling factor was determined and the date the population was scaled to. For example, population data scaled from 2010 to 2018 using a blanket factor of 2 percent growth. Ideally, historic growth or national census growth estimates are used for scaling.

If by admin level: Source of GIS boundaries- if different than population source. Also include the level of population data (country, tract, state).

If originally posted by grid: What is the source of the gridded data (i.e., WorldPop, LandScan). In addition, the original source of population data should be provided covering the questions above, which should be available through the provider. Include scale, source, version, date of gridded population data.

Dasymetric mapping (if applicable): Dasymetric mapping can be used to spatially focus exposure to settled areas within administrative units. For example, global gridded population data sets allocate population to land patterns associated with the development or known settlements within administrative units. For coastal hazards and riverine hazards, allocating exposure evenly throughout an administrative area such as a census tract will typically result in overestimation of the risk- as regions are delineated with water bodies as boundaries. In these cases, it is important to use remote sensing or other methods to extract non-developed areas within a tract so that the hazard is not over estimated. When exposure is posted by a uniform grid, it is important that end users understand limitations with regard to bodies of water. National-level exposure maps need to flag whether dasymetric mapping has been used, and what remote sensing and other databases were used in the process. If dasymetirc mapping is not used at this level of analysis, there should be an acknowledgment of this as a limitation, and an exploration of any possible impact on the final risk assessment given the resolution of the data, nature of the country, and hazards to be assessed.

Structural distribution: The method of developing the structural distribution should be discussed, including a bibliographic reference of each database or literature source, and the names of local experts solicited for their opinion. If there are adjustments for urban/rural or other factors, multiple distributions and acknowledgement of the source of adjustment with a bibliographic reference need to be provided. If sampling was used, the method of sampling and the number of samples needs to be explicit.

Number of buildings: Number of buildings can either be directly inferred from remote sensing data or from population data.

If inferred from population data: The method of inferring the number of people per household, the number of buildings per household, or the number of buildings per person needs to be provided. If there are adjustments for urban/rural areas, population density, or other factors these need to be explicitly stated and documented. Key values need to be provided for each country. If sampling was used, the method of sampling and the number of samples needs to be explicit.

If inferred from remote sensing data: The basic method of data extraction, base data layer, or source needs to be acknowledged. If inferred from an interpreted global remote sensing product (e.g., GHSL, GHS), the method of inferring the number of buildings from the provided product needs to be explicitly noted. If sampling was used, the method of sampling and the number of samples needs to be explicit.

If inferred from a combination of remote sensing data population data: The sources of each independent data set need to be acknowledged, as well as a complete description of the method of inference.

Building area: The assumptions as to the building area by type of construction or by occupancy needs to be provided. If sampling was used, the method of sampling and the number of samples needs to be explicit. If there were additional adjustments by other spatial data sets (such as urban/rural delineation), and the source of data and a bibliographic reference of the data used for adjustment should also be disclosed.

Building height: Assumptions as to the distribution of buildings by height range, if not captured by the structural type, need to be explicit. If sampling was used, the method of sampling and the number of samples needs to be explicit. If there were additional adjustments using other spatial data sets (such as urban/rural delineation), then the source of data and a bibliographic reference of the data used for adjustment is required.

Replacement cost: Estimates of replacement cost are generally provided based on the area of building stock by structural classification, or by occupancy. Replacement cost can be based on urban/rural delineations or other classifications from remote sensing data or estimated from GDP. Bibliographic references of all source data should be included.

1.2.1 Level 2 – Flowcharts

Below is the Level 2 principle flowchart. The subsequent flowcharts give additional detail for each segment.

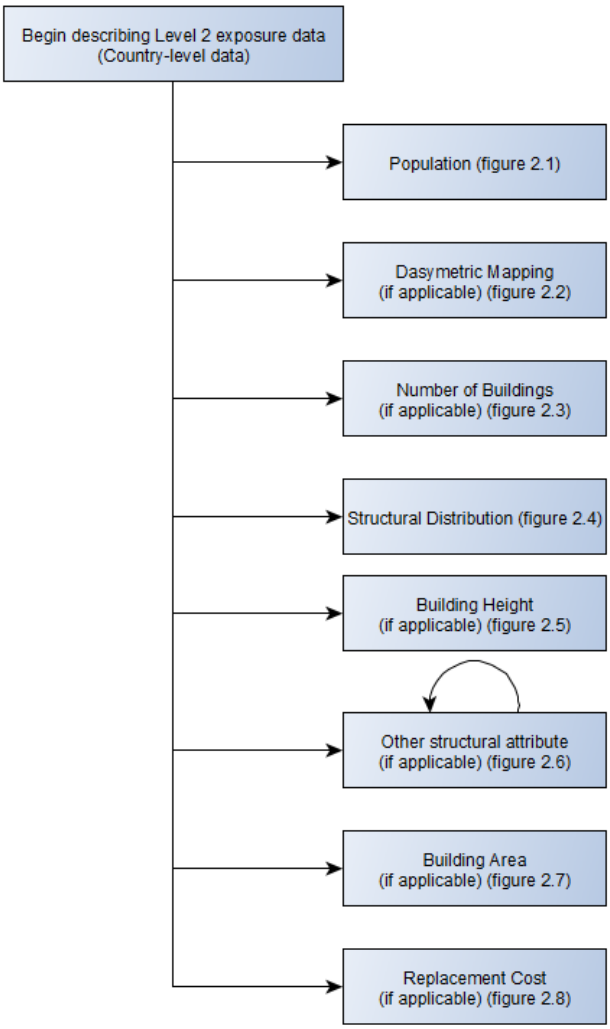

Figure 1.2.1: Level-2 Principle Flow chart

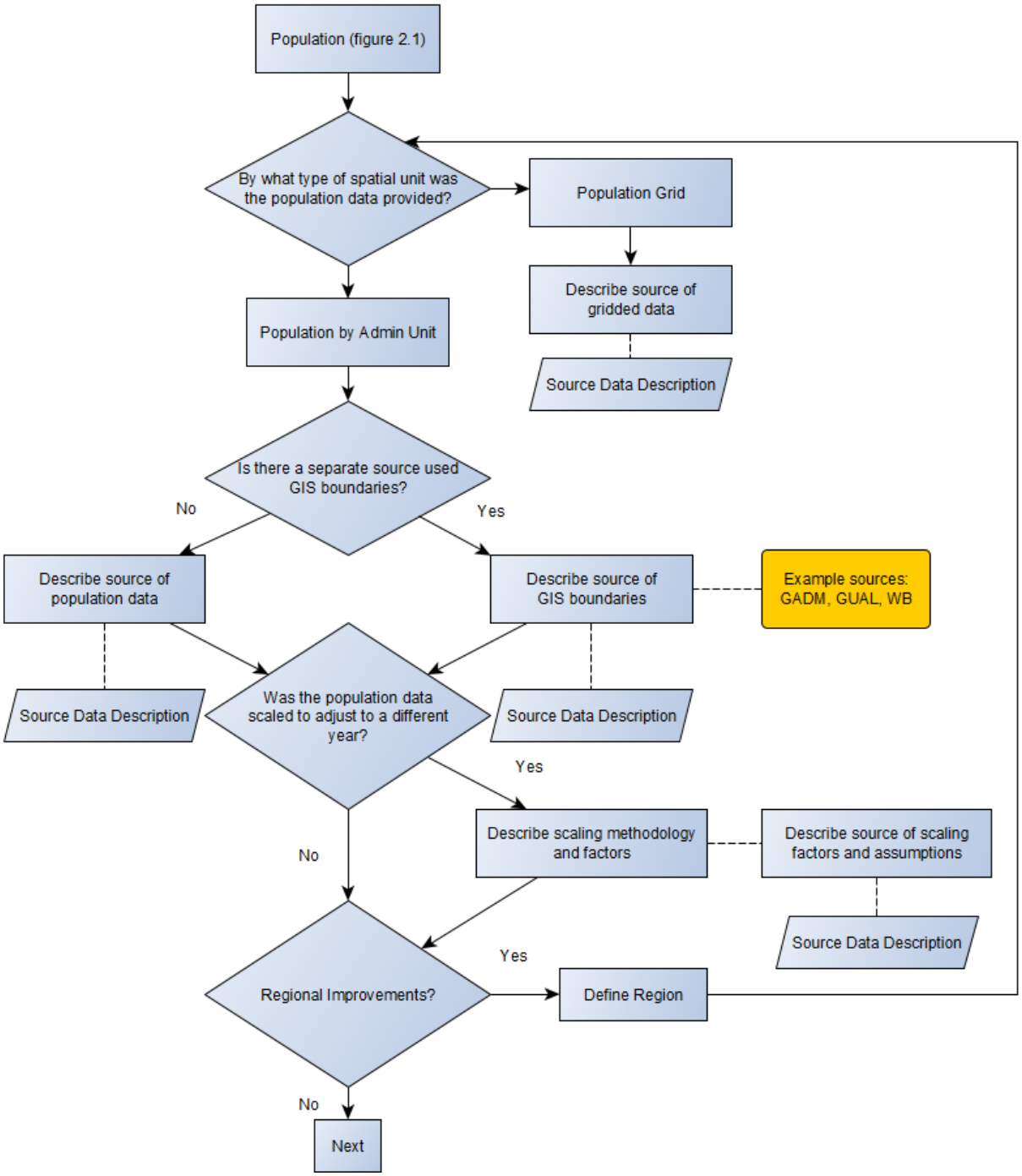

Figure 1.2.2: Method for determining population counts and obtaining useful information.

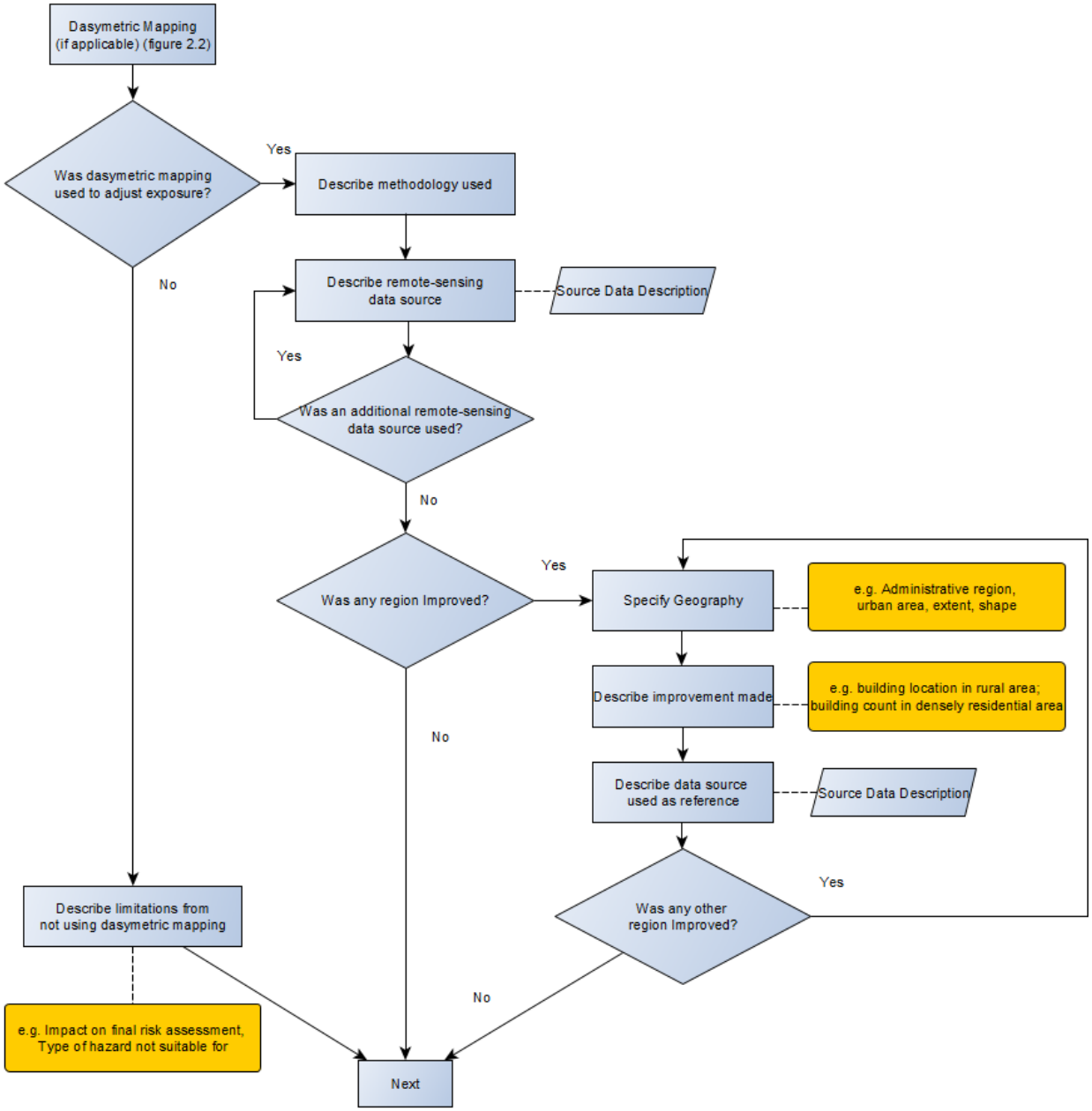

Figure 1.2.3: Flow chart for describing data improvements through dasymetric mapping.

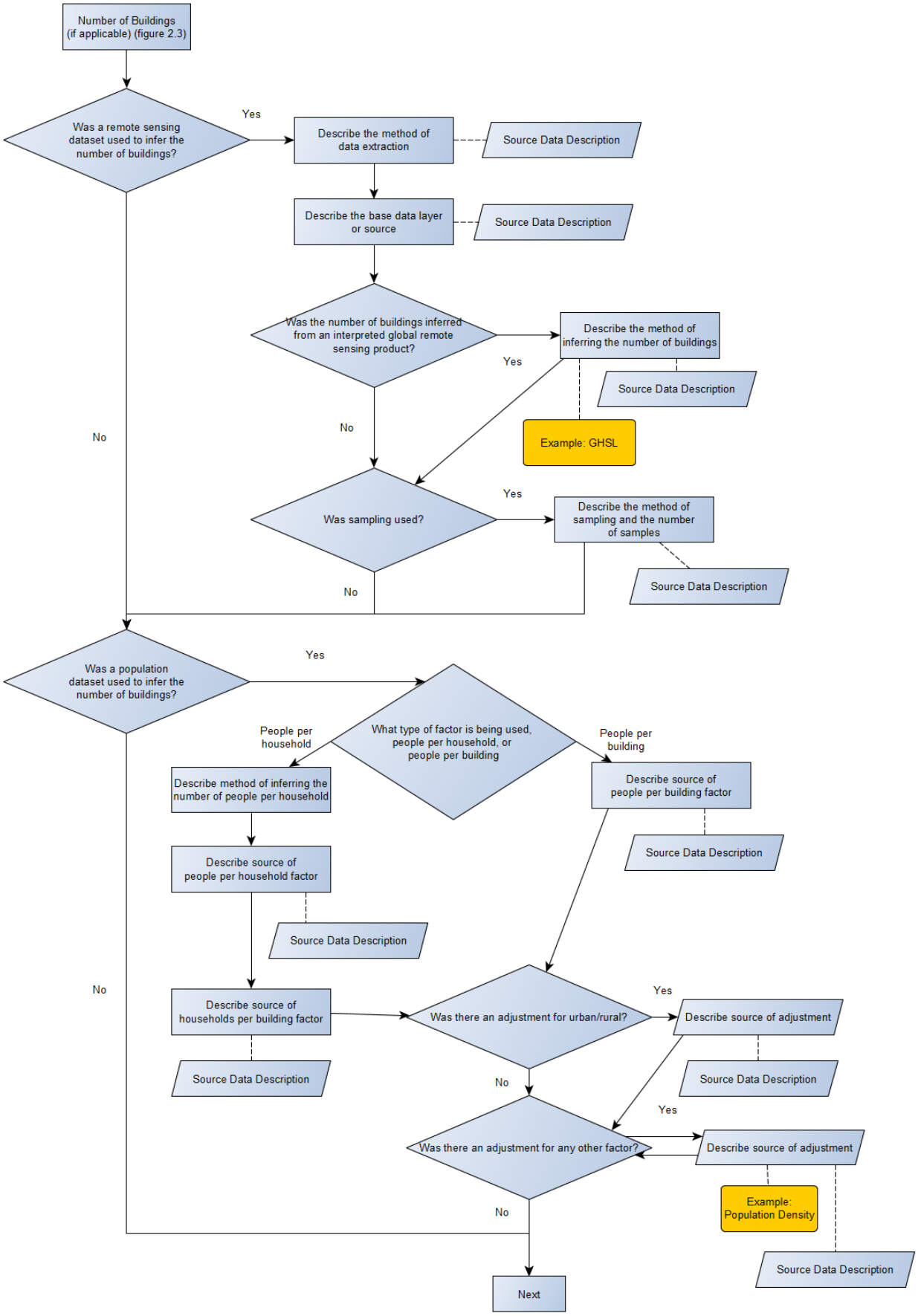

Figure 1.2.4: The flowchart displays the path for determining the number of buildings in a region or study.

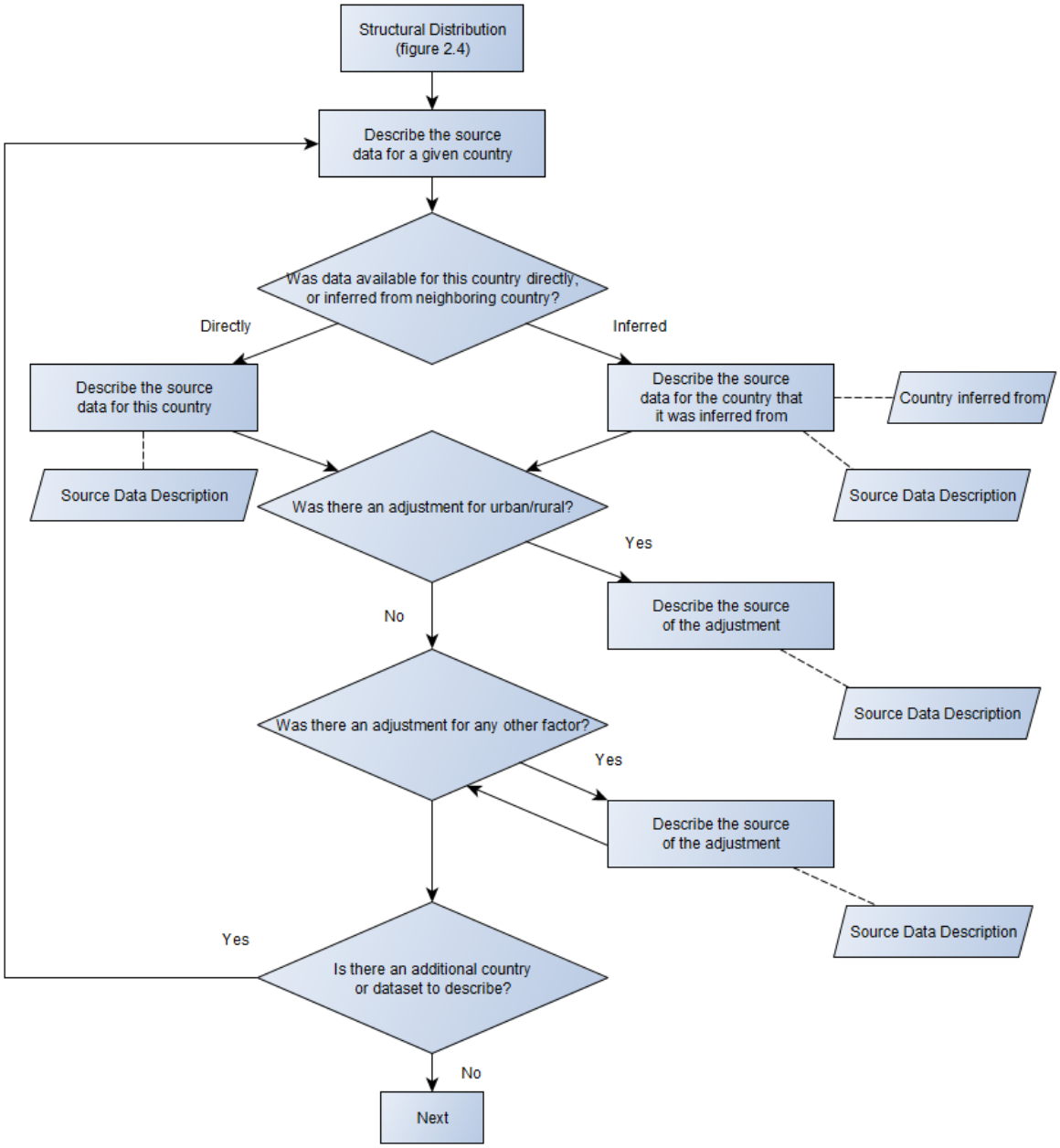

Figure 1.2.5: Flowchart for determining the structural distribution in a study.

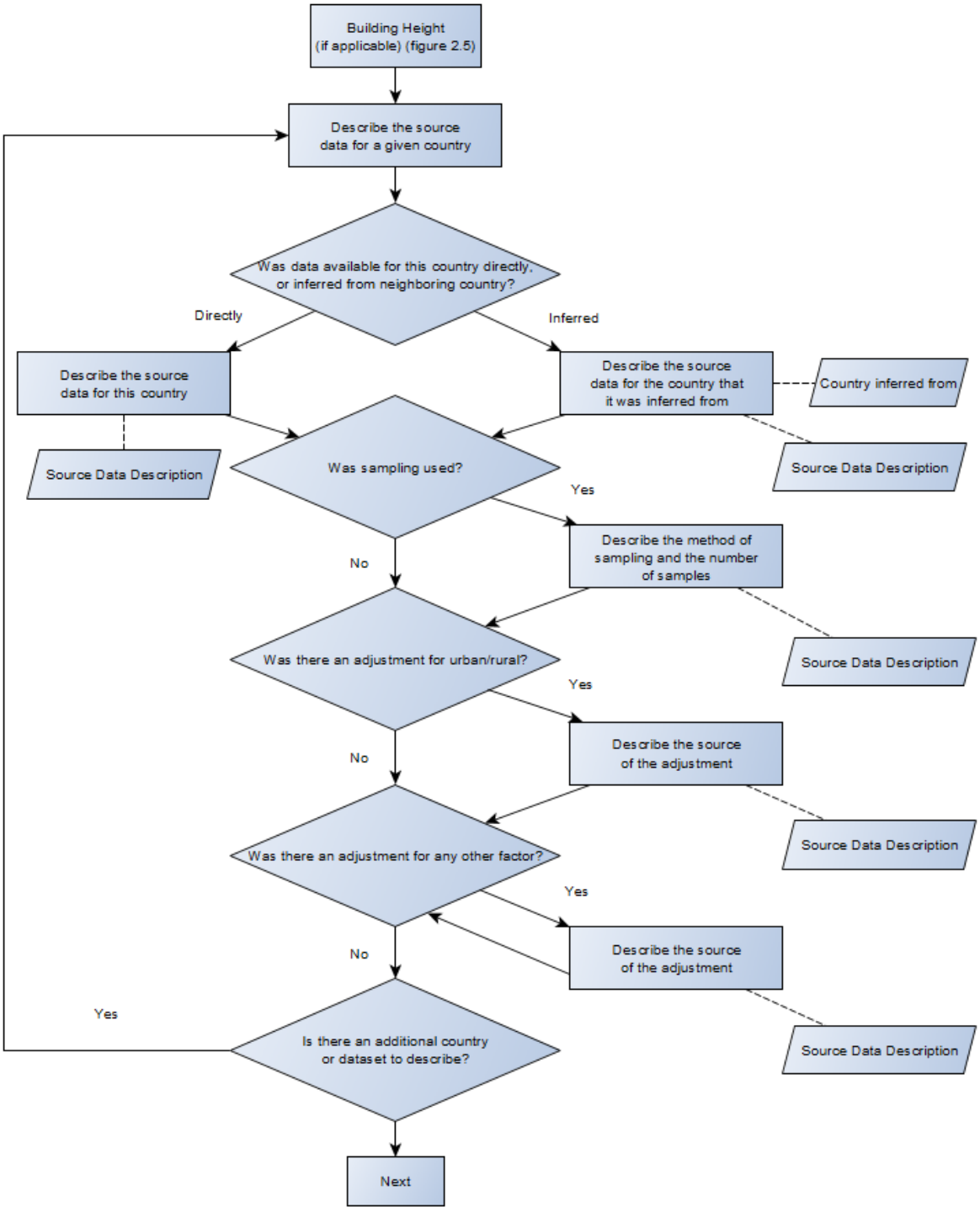

Figure 1.2.6: Guide for gathering building height data.

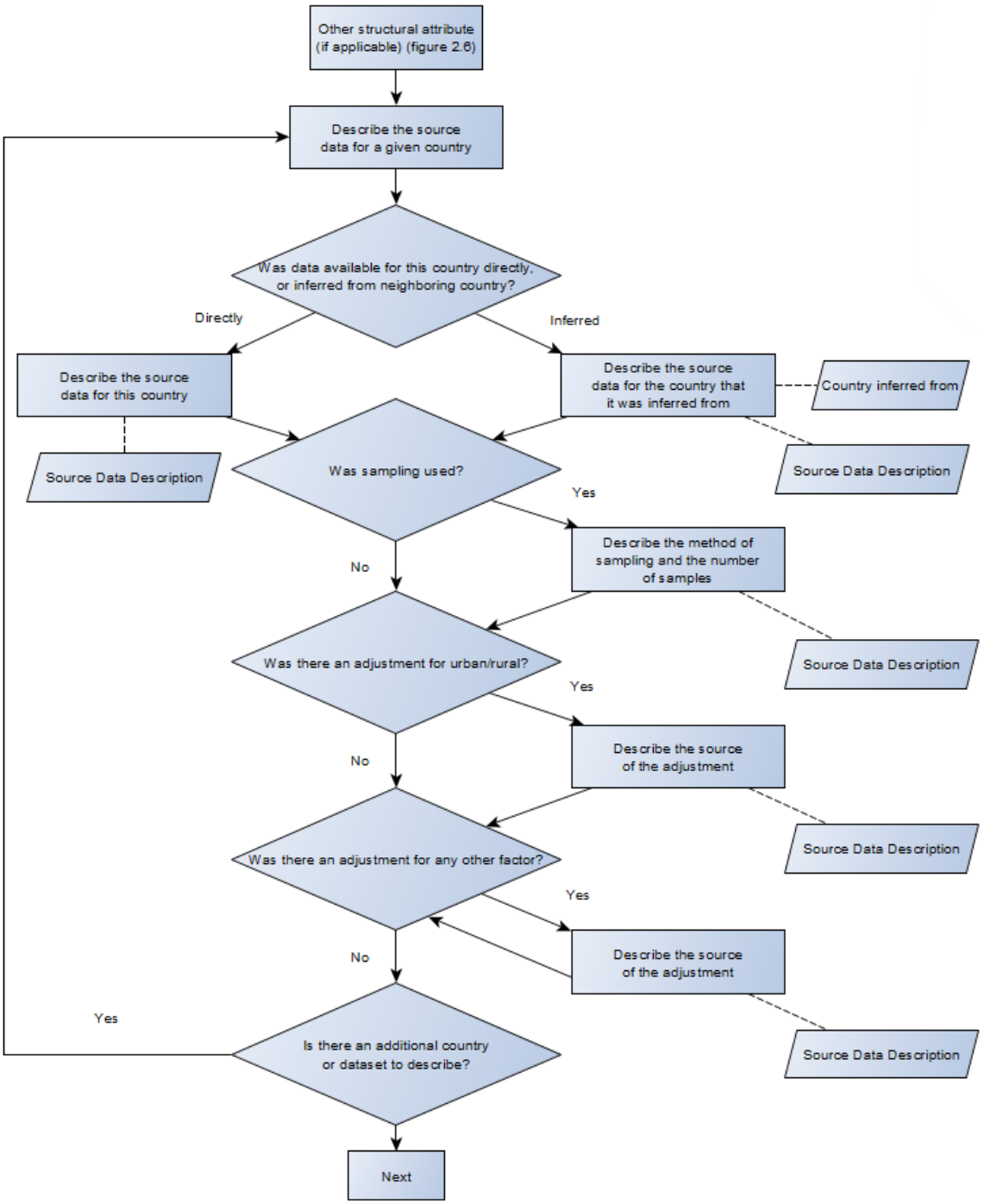

Figure 1.2.7: Flowchart for gathering additional information regarding the structural attribute data.

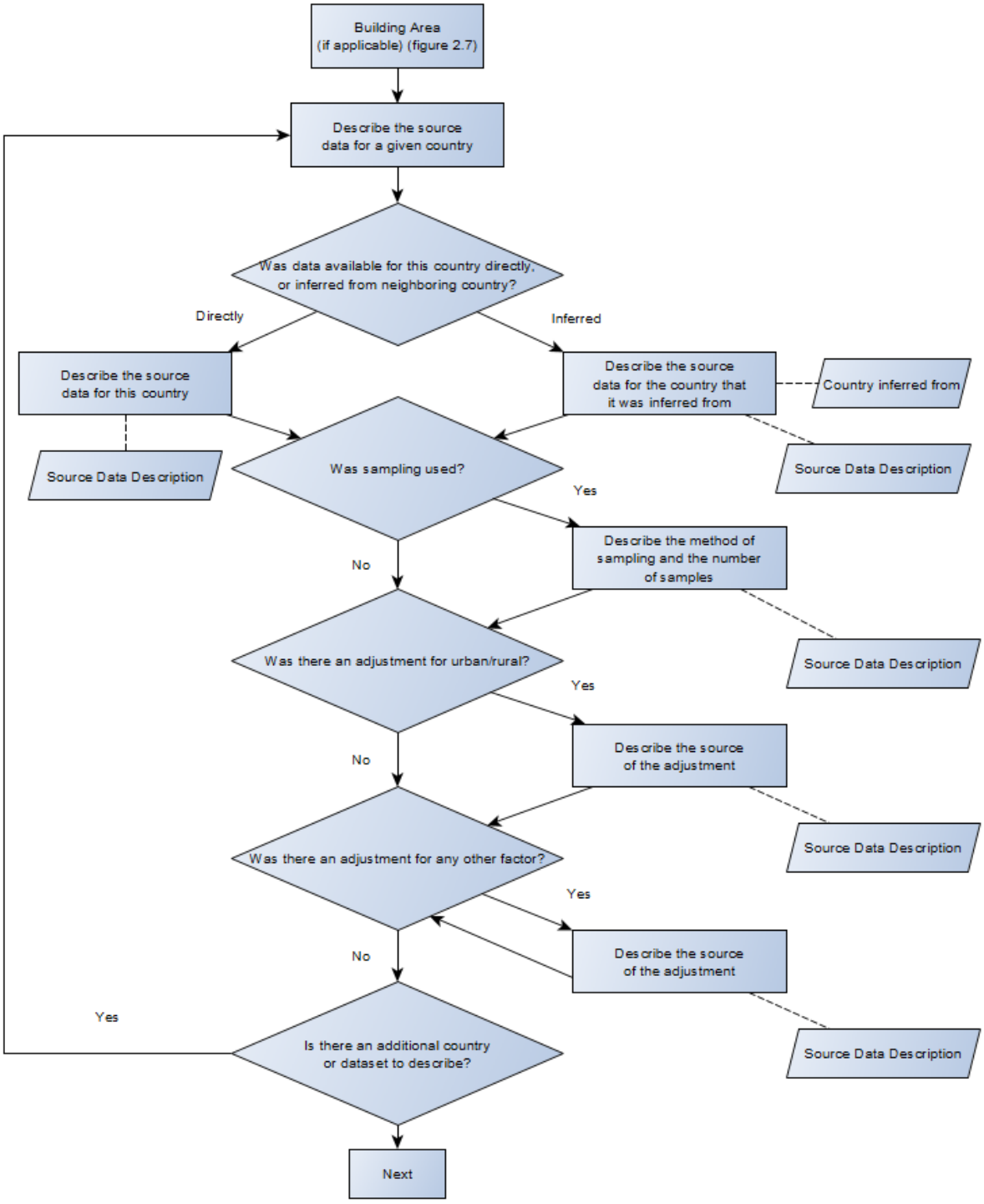

Figure 1.2.8: The above flowchart guides users through an exercise to establish a building area.

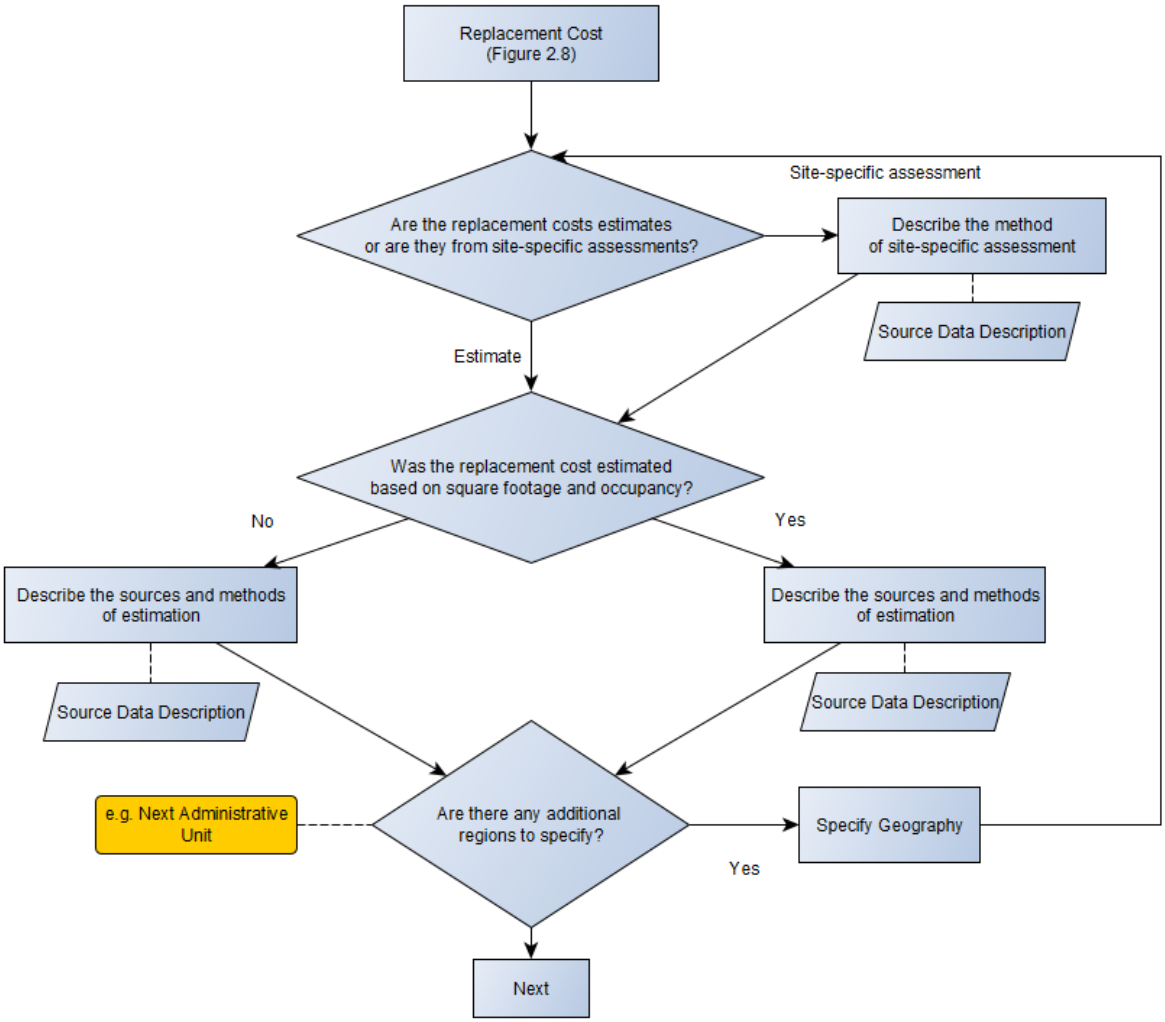

Figure 1.2.9: Flowchart displaying the path for calculating replacement cost.

1.3 Level 3 – Improved Data – Sub-national Scale

Level 3 data improves on national scale data by incorporating additional data sets that refine the spatial distribution of exposure and assignment of vulnerability throughout the country. Given that there are many ways that this can be accomplished, and that the integration and fusion of multiple data sets is a complex process, it is important to specify exactly how the data has been improved. Level 3 should represent a considerable improvement over Level 2 through the acquisition of all nation-specific data. There should be considerable effort to increase the accuracy and variability of the estimates of structural distribution throughout the country. For example, regional occupancy to construction type distributions or variation by land use classification. In addition, there should be an effort to address any limitations in the spatial representation of the exposure that are poorly represented, for example, by digitizing development patterns in the top urban areas or localizing exposure in very large census tracts.

Population: The source of population data should be included with a bibliographic reference and link if applicable. If there has been scaling to adjust population to current era, the factors used for scaling, how the scaling factor was determined and the date population was scaled to should be provided, for example, population data scaled from 2010 to 2018 using a blanket factor of 2 percent growth. Ideally, historic growth or national census growth estimates are used for scaling.

If by admin level: Provide source of GIS boundaries if different than population source. Acknowledge the level of population data (country, tract, state) as well.

If originally posted by grid: Acknowledge the source of the gridded data (i.e., WorldPop, LandScan). In addition, the original source of population data should be provided covering the questions above, which should be available through the provider. Disclose scale, source, version, and date of gridded population data.

Dasymetric mapping (if applicable): Dasymetric mapping can be used to spatially focus exposure to settled areas within administrative areas. For example, global gridded population data sets allocate population to land patterns associated with the development or known settlements within administrative units. It is possible to use the dasymetric mapping that has been done in these databases to distribute improved population data. The analysis needs to identify what data sets or methods were used for dasymetric mapping, and if no data was used, there should be an acknowledgment of this as a limitation, and an exploration of the possible impact on the final risk assessment given the resolution of the data, nature of the country, and hazards to be assessed.

Structural distribution: The method of developing the structural distribution should be explained in detail. Use of pre-existing studies should be explained, including a bibliographic reference of each database or literature source and a discussion of what was done to both assess and improve the distributions. Typically, there will be some level of survey in a Level 3 study. In addition to structure type, the vulnerability assessment at the national level may consider the advent and adoption of building codes or the quality of construction. If there has been surveyed data, then the type of survey conducted and whether it was a remote of field survey should be detailed, including field tools used, number of surveys, and qualifications of the staff conducting the surveys. For example, field surveys were conducted throughout the metropolitan area with engineering students assessing buildings and passing indeterminate results to a structural engineer. 100 buildings were surveyed, with 50 samples in the CBD and 50 throughout the residential areas. Or alternatively, a remote survey was conducted using Pictometry data of 500 buildings randomly selected based on latitude and longitude. Interns classified wood frame and single-family buildings, identifying others for examination by a structural engineer. In cases where the structure

class was difficult to ascertain, engineers gathered data from Google Street View and the County Tax Assessor.

If there are adjustments for the CBD or commercial/industrial districts, these need to be made explicit and multiple mapping schemes need to be provided, acknowledging the spatial source of data used for adjustment with a bibliographic reference.

If data was digitized and was project specific, the extent of digitization should be noted.

If local experts provided the distribution of structures through a survey, the number of experts and their qualifications should be noted.

If the structural distribution is aided by additional data such as reports that indicate construction and retrofit trends, these need to be cited.

If the structural distribution is gleaned from detailed point level data available for a given region, the process of aggregating the results, typing the distribution to other attributes, such as occupancy or land use, and filling gaps in the data should be discussed.

Typically, a combination of the above methods is used, and so a discussion of how the final distributions were amalgamated from more than one source is warranted.

Number of buildings: Number of buildings can either be directly inferred from remote sensing data or from population or number of housing units. If a direct count is available from a building census, this should be noted.

If inferred from population data: Disclose the method of inferring the number of people per household, the number of buildings per household, or the number of buildings per person. If the population distribution by number of housing units in a building that may be available in a national census has been used to determine the number of buildings, the method of using that data should be described. If there are adjustments for urban/rural areas, population density, or other factors these need to be explicitly stated and documented. Key values need to be provided for each country. If sampling was used, the method of sampling and number of samples needs to be explicit.

If inferred from remote sensing data: The basic method of data extraction, base data layer, or source needs to be acknowledged. If sampling was used, the method of sampling and number of samples needs to be explicit.

If inferred from point or polygon level data for an extended region: The extent of point and polygon data needs to be provided. The method of extrapolating these numbers to a wider area also needs to be detailed. Examples include using linear regression on population, or percent urbanization.

Building area: The assumptions as to the building area by type of construction or by occupancy needs to be provided. If a sampling of building footprints was used, the method of sampling and number of samples needs to be explicit. If there were additional adjustments by other spatial data sets (such as urban/rural delineation), and the source of data and a bibliographic reference of the data used for adjustment.

Building height: Assumptions as to the distribution of buildings by height range, if not captured by the structural type, need to be explicit. If sampling was used, the method of sampling and number of samples needs to be explicit. Disclose if there were additional adjustments by other spatial data sets (such as urban/rural delineation), and the source of data and a bibliographic reference of the data used for adjustment.

Replacement cost: Estimates of replacement cost are generally provided based on the area of building stock by structural classification, or by occupancy. Replacement cost can be based on urban/rural delineations, regional differences, state adjustments, or other classifications from remote sensing data. Bibliographic references of all source data should be included.

1.3.1 Level 3 – Flowcharts

Below is the Level 3 principle flowchart. The subsequent flowcharts give additional detail for each segment.

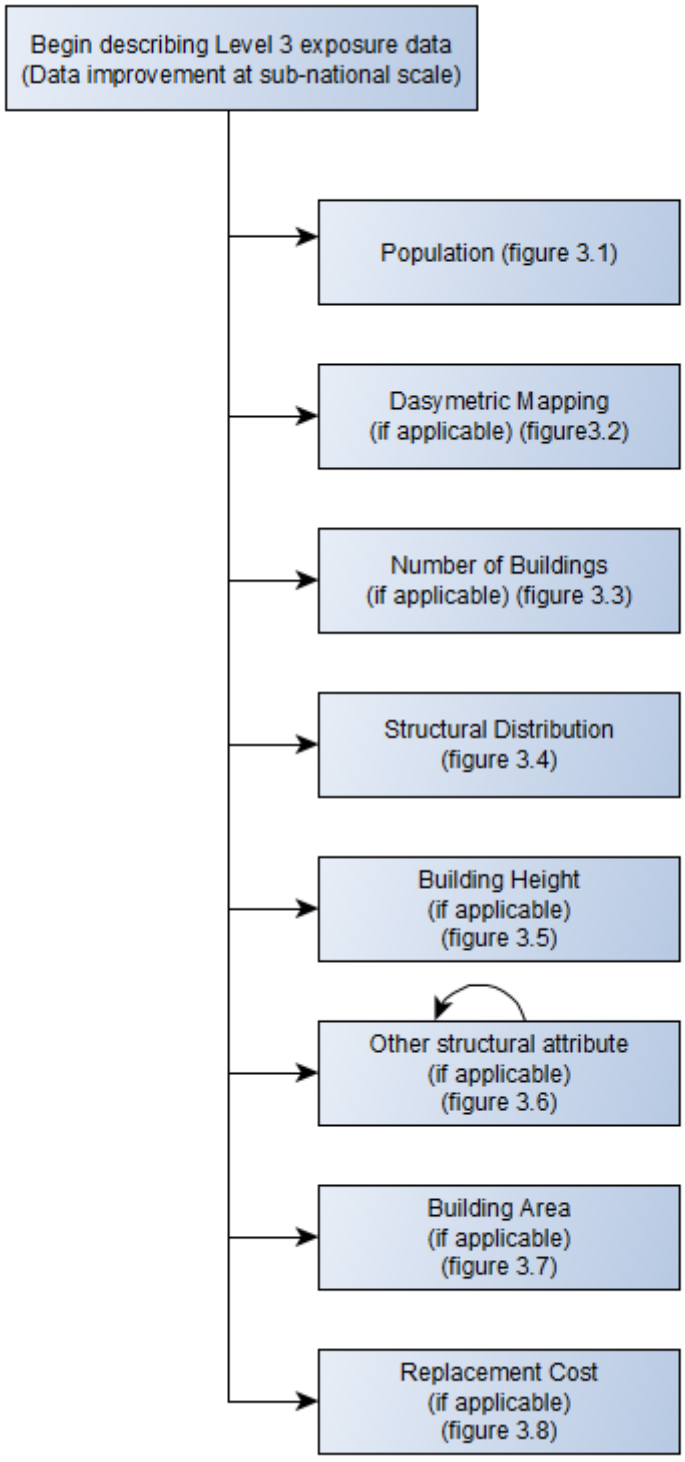

Figure 1.3.1: Level-3 Principle flow chart.

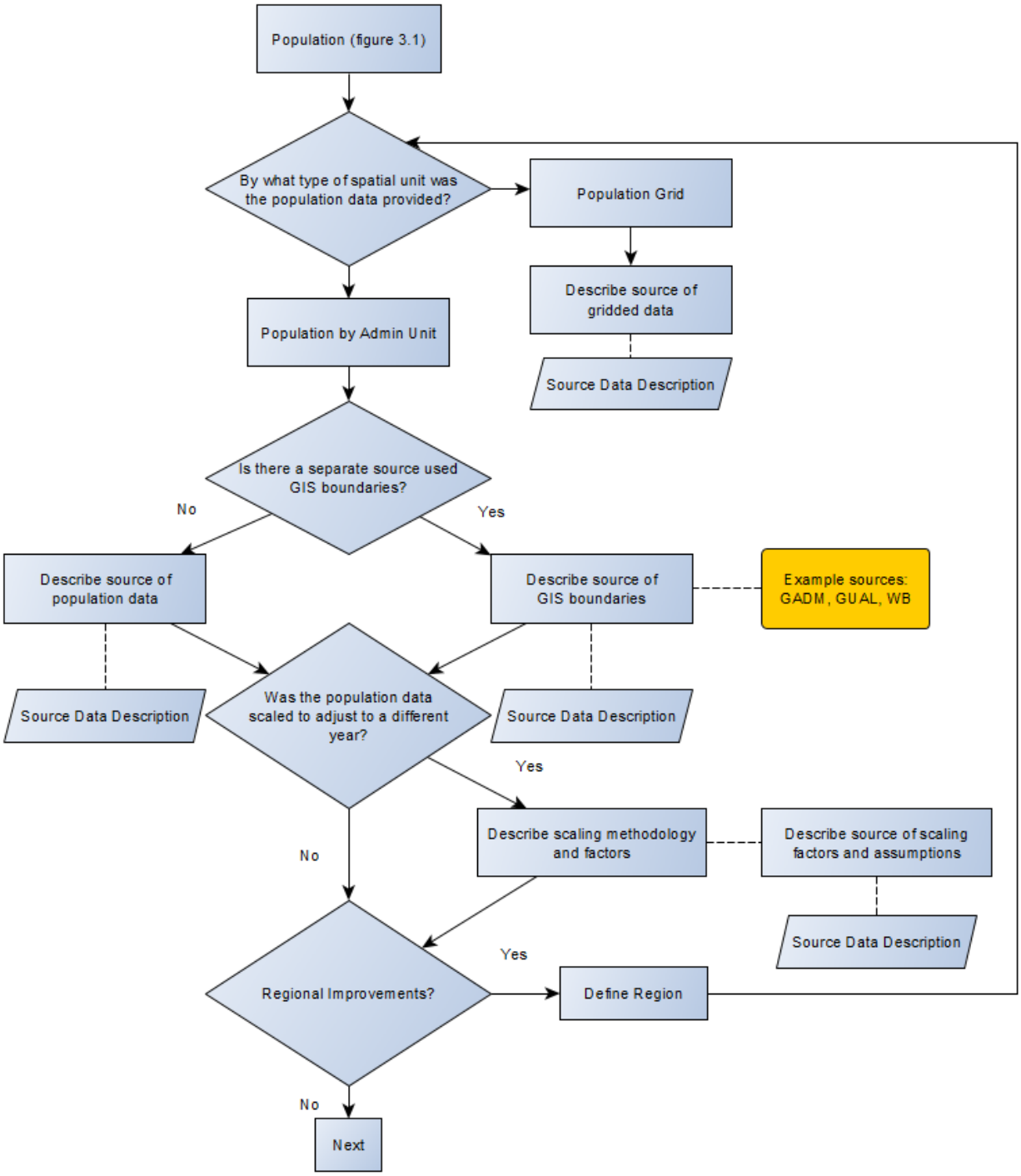

Figure 1.3.2: Method for determining population counts and obtaining useful information.

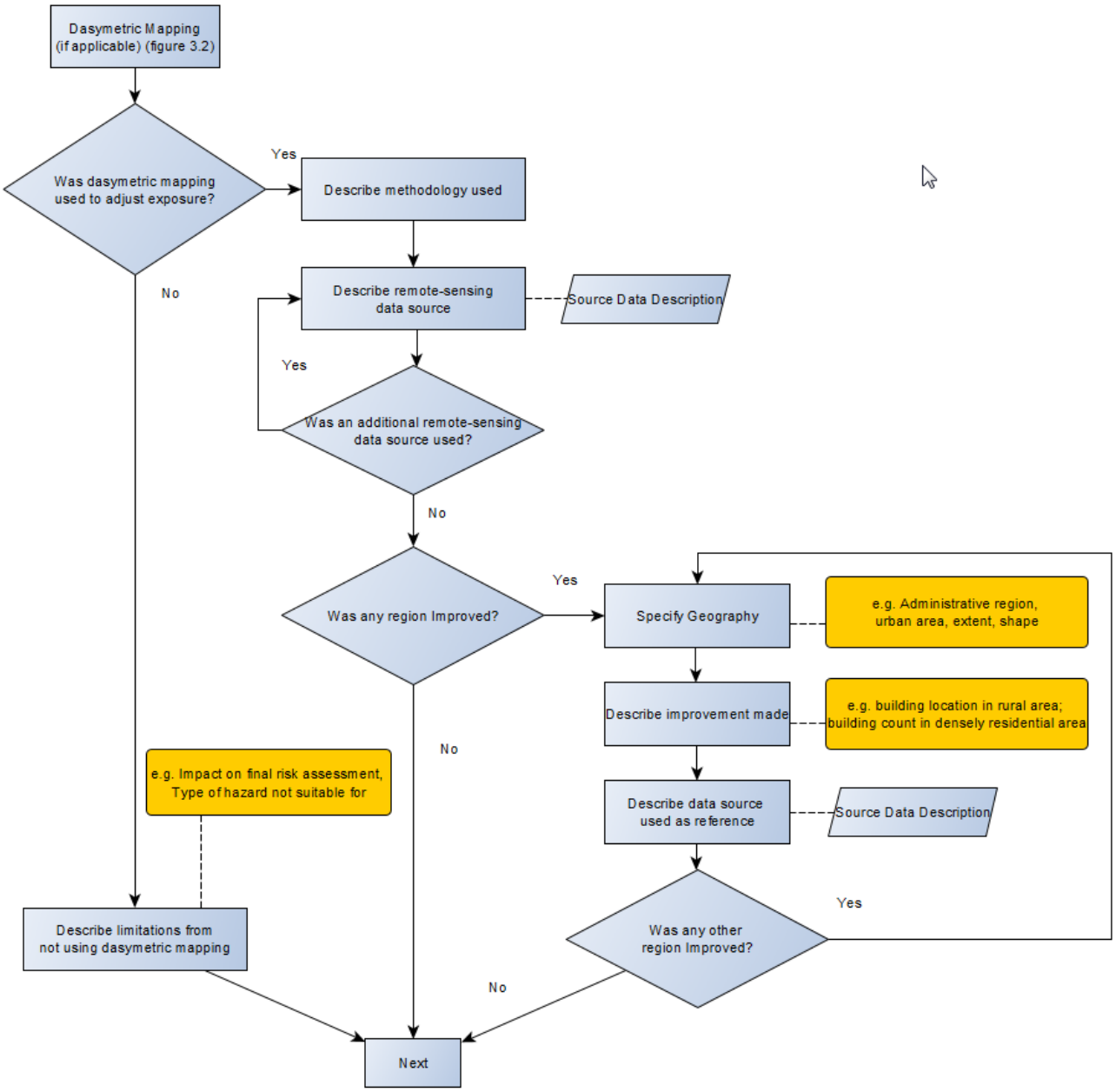

Figure 1.3.3: Flow chart for describing data improvements through dasymetric mapping.

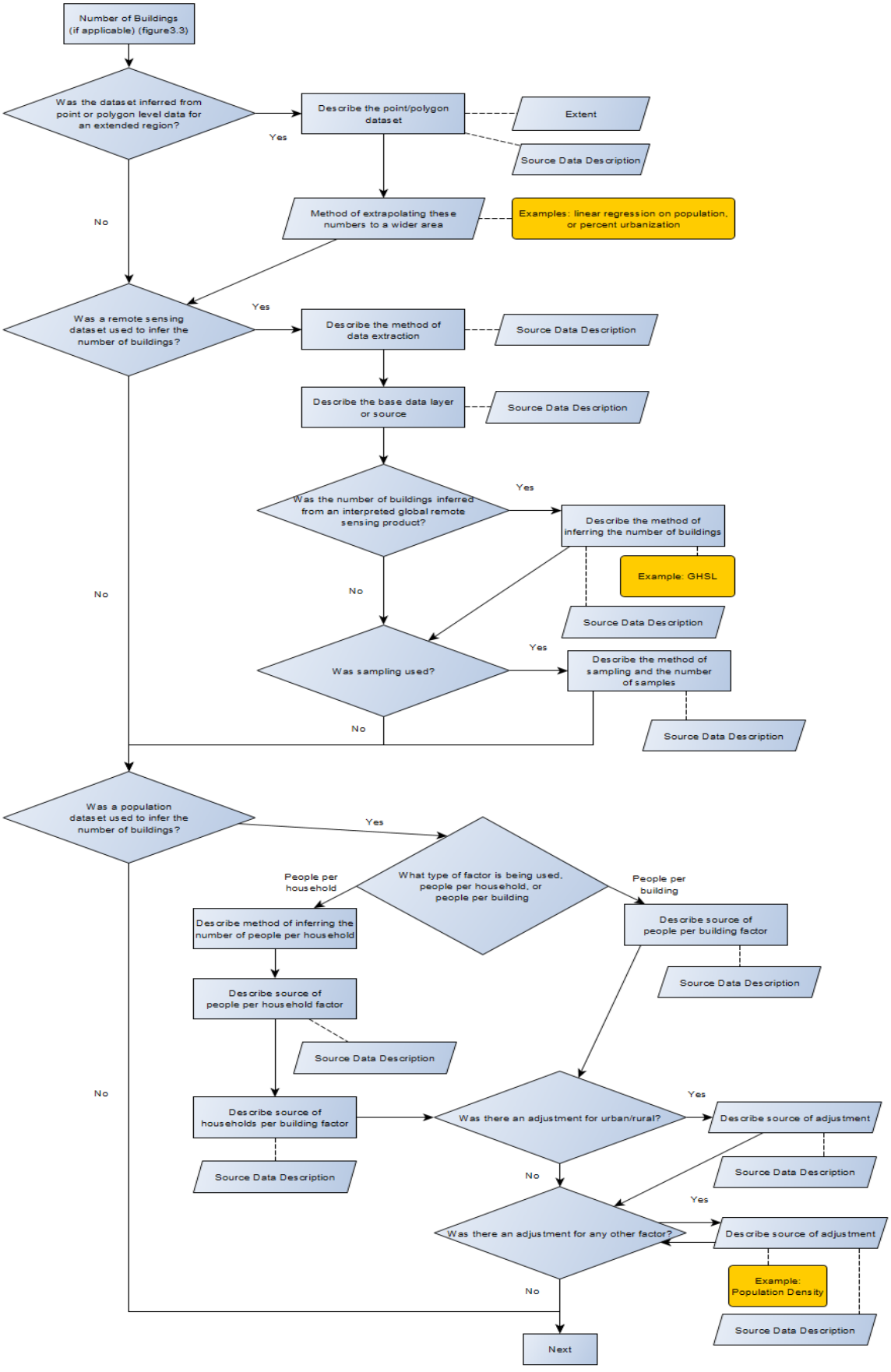

Figure 1.3.4: Flowchart for obtaining the studies number of buildings.

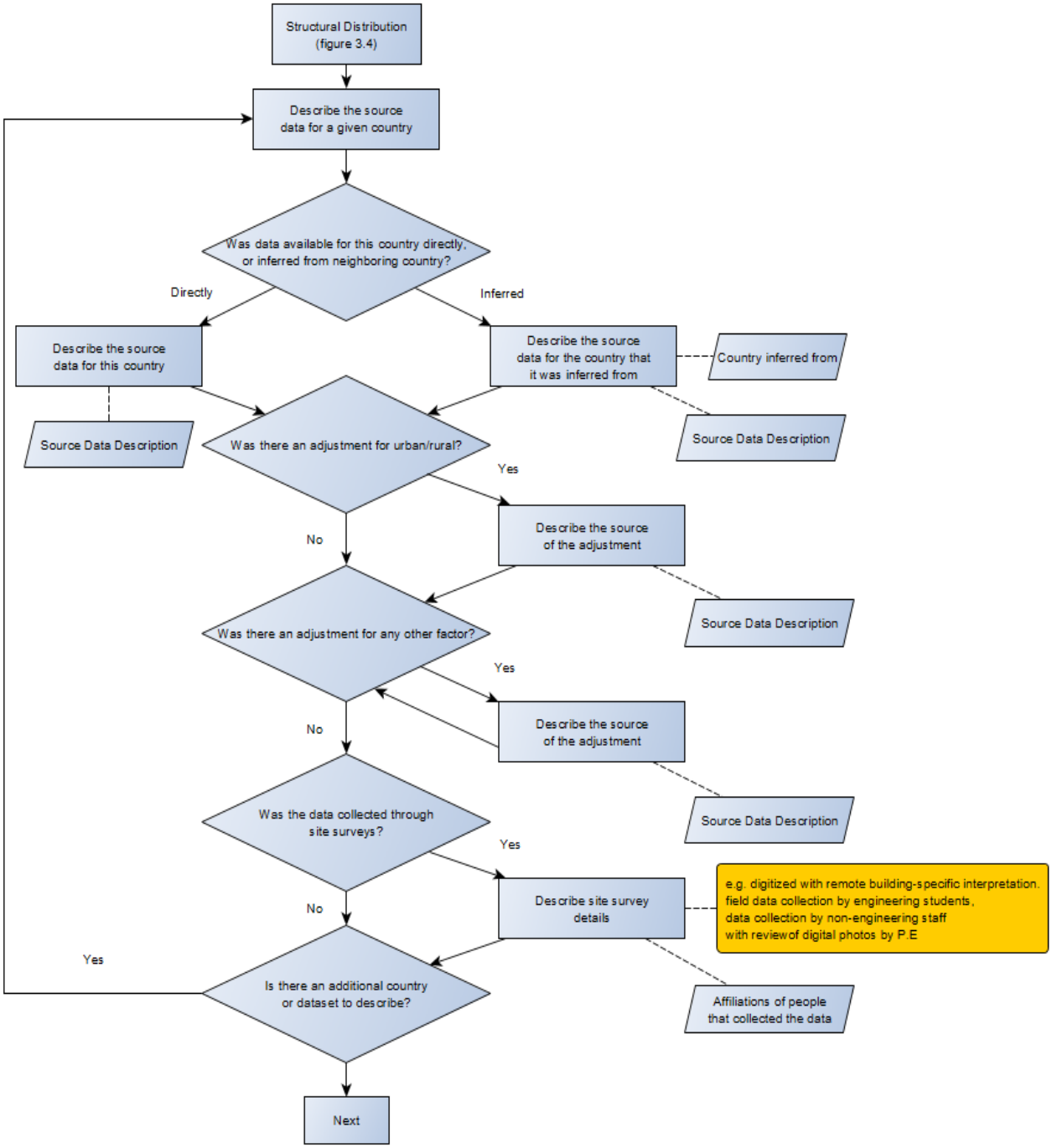

Figure 1.3.5: Flowchart for collecting information about the structural distribution of the region.

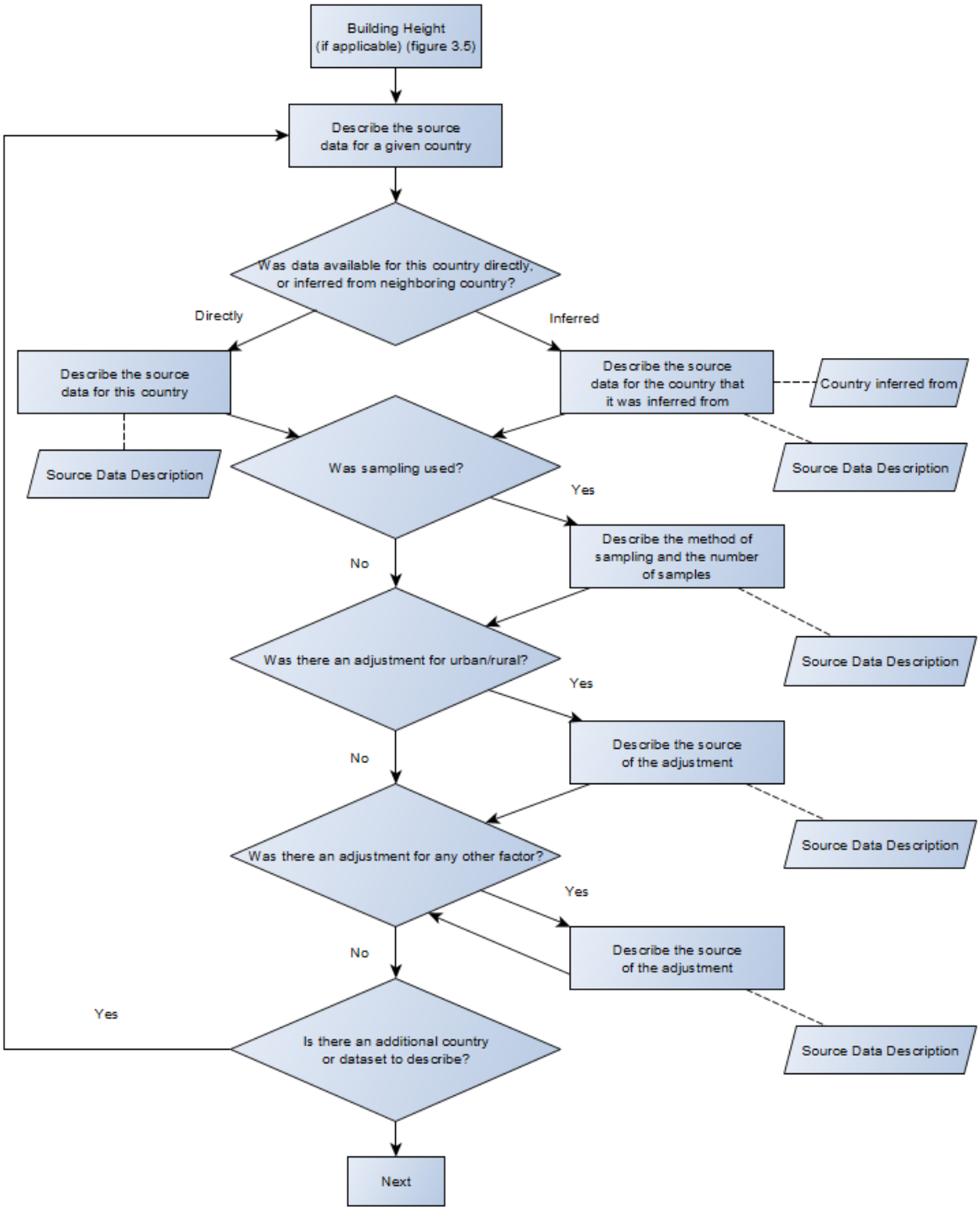

Figure 1.3.6: Flowchart for describing building height and the data behind the value.

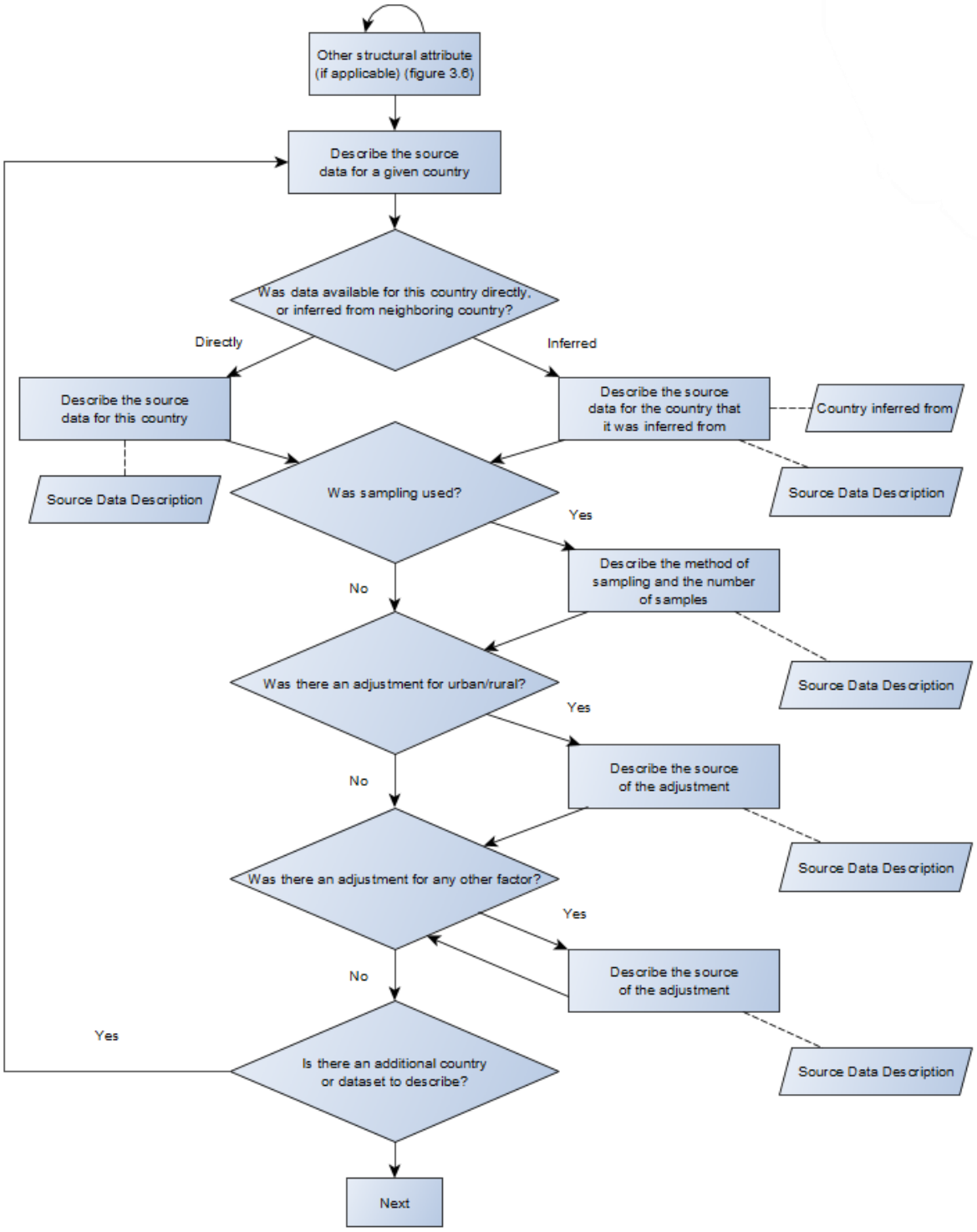

Figure 1.3.7: Flowchart example for additional structural attributes.

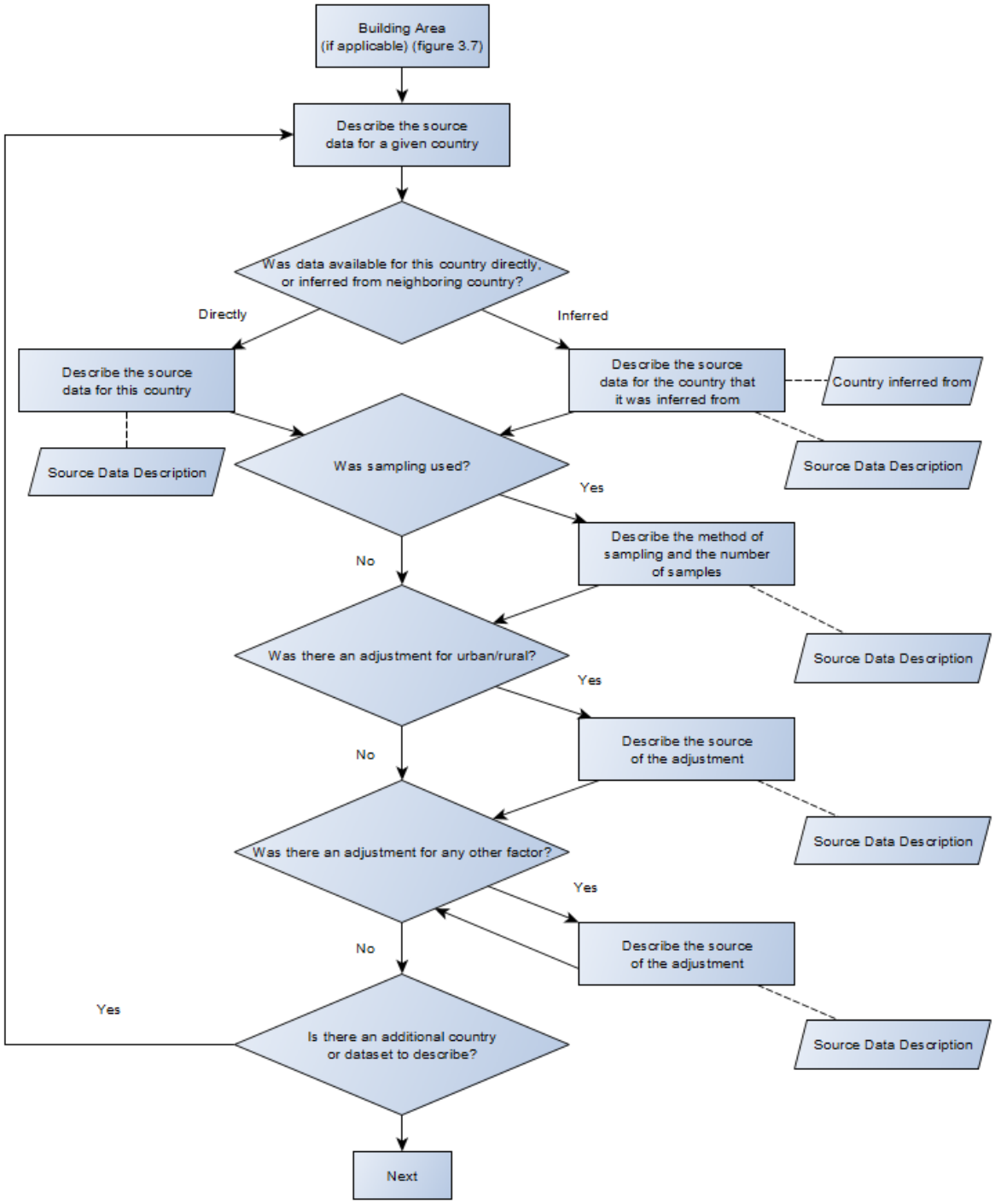

Figure 1.3.8: The flowchart guides the user through an exercise to establish a building area.

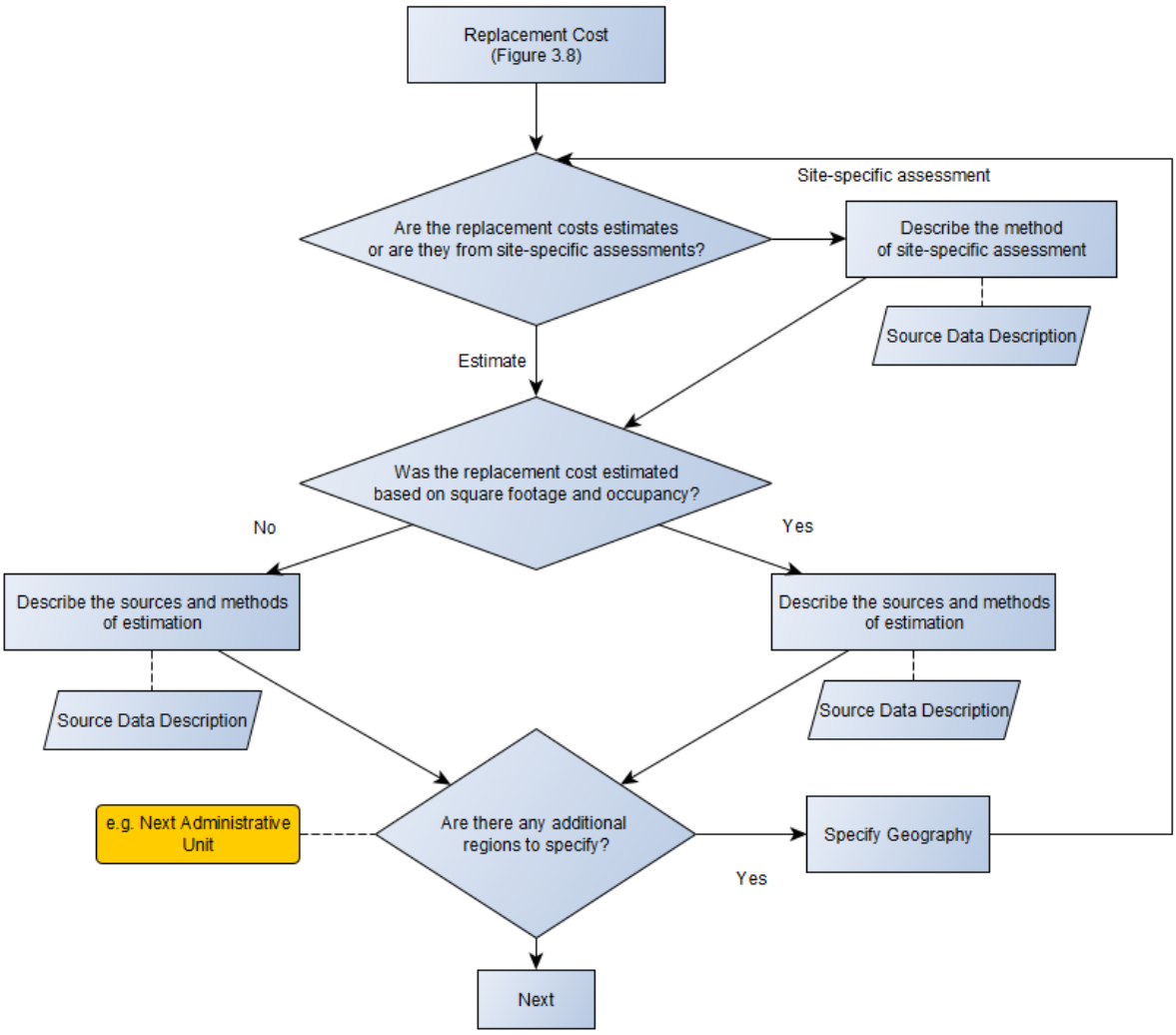

Figure 1.3.9: Flow chart for gathering information regarding and calculating replacement cost.

1.4 Level 4 – Aggregated Point Level Data

When site-specific data is available for the general building stock, it can be used in several different ways. If the data is available for only a portion of the area, is old, or is incomplete spatially, the data should be analysed and used to update estimated building counts or building area given various development patterns, height in stories, or building occupancy. If the data is spatially complete for a given study area but lacks the attributes to assess vulnerability, the data should be aggregated and the distribution of key attributes should be assessed separately and assigned to the general building stock through "mapping schemes" that provide a distribution based on a known factor. If, for example, occupancy is known, then the structural distribution can be assessed for each occupancy class. If occupancy is not known, land use or development patterns can be used as a proxy, or land use and development patterns can be used to further refine structural distribution estimates by occupancy. By providing these data as distributions associated with aggregated regions, rather than as default attributes associated with each site, the exposure more accurately represents data that is inferred or assumed.

In addition, there may be circumstances when assessing aggregated exposure is preferred to point-specific data due to processing speed or requirements. Assessing every building location with probabilistic risk tools may require considerable computational resources. Aggregating the data to a grid or admin unit reduces the computational time significantly. If computation time is the primary reason that Level 4 data is presented, rather than Level 5, and there is occupancy and structural information available on a per-site basis, it should be used to develop a custom structural distribution for every aggregated unit, admin or grid cell, as to reflect the accuracy available in the point data. Given the quality of aggregated structural data will be much higher than inferred data, it is important that the documentation reflects the process accurately.

Site-specific data source: The source of the site-specific data needs to be referenced and the original purpose discussed (i.e., GIS mapping, tax assessor records, real estate inventory).

Vintage: The last date that the data was updated needs to be referenced.

Location precision: Whether the original data was geocoded by address or if the data is located by "rooftop", based on building footprints needs to be stated. If the data has been geocoded, the data may need to be scaled to accommodate records that could not be geocoded.

Limitations: If there are known limitations (exclusion of schools or government buildings), these limitations need to be acknowledged.

Administrative data source: If the data is aggregated by an administrative district, postal codes, or any other polygonal source that has been obtained externally, the source and vintage of that data needs to be stated. For example, if GADM data was used to aggregate the data using the Level 4 administrative levels, the source of the GADM data and date needs to be specified. If the data is aggregated by census blocks, the source of the census and the date needs to be specified. It is assumed that the entire extent of the administrative districts provided is represented. For example, if data is aggregated to the province level, that all districts with that province are represented in the site-specific data. If not, the data should be clipped using a GIS function to the extent of data availability, and this process should be documented. The extent of the point data can also be provided in an additional file, but if these files are separated as data passes to potential end users, the data may be used inappropriately.

Gridded data: If the data is aggregated to a standard grid, such as a national grid or a variable resolution grid, the specifications, source, version, projection, datum, resolution, and date need to be specified. If the grid is custom, the projection, datum, and resolution need to be specified.

Replacement cost: If replacement cost is aggregated from the original source, this needs to be explicit, as well as any known limitations (i.e., data provided by a tax assessor may be low, or not include public buildings). Replacement cost is typically derived through a combination of building area, occupancy class, and sometimes building height, size, and level of income in a given region. If the replacement cost is estimated from known data, such as size and occupancy and a third-party estimate such as construction manuals or a survey of local experts, the method and source of estimates need to be acknowledged. Loss results are highly sensitive to replacement cost estimates, so it is particularly important to state known limitations, such as potentially high values given the original source materials assumption of high-quality construction. The date of the per-unit estimate is critical, as the replacement cost is highly volatile. In addition, if an exchange rate was used, the source and date of the exchange rate should be noted. Any scaling of replacement cost to reflect low quality or informal construction should be described.

Assumptions of key parameters: As described in the introduction to Level 4, a key reason for posting exposure data at an aggregated level even though site-specific data is available, is the robust representation of assumed parameters, which may include occupancy, structure type, vintage, or height in stories. The methods used to infer distributions need to be explicit, as well as all survey techniques, sampling techniques, or source material used. Equally, if data was available in the source data, this needs to be acknowledged as well as any "mapping" or translation from the native taxonomy into the taxonomy used for risk assessment. For example, assuming structural classes for risk assessment from fire codes or building materials, or translating detailed occupancy classes into a simpler structure. Often assumptions are difficult to justify, but it is more important to document them than to exclude them from the documentation.

Completeness test: There should be an independent comparison of the aggregated data with a separate data source, such as the census population. Ideally, the data is compared with the same units posted, but the data can also be aggregated separately to census units for assessing completion. A discrepancy does not necessarily reflect poorly on the source data, as the site-specific data may be more recent or more complete than a census. The purpose of the test is to assure that the data is adequately complete for the study area. The source data used for comparison should be acknowledged, and a general description of the test, results, and findings summarized. If there has been an adjustment to the exposure to reflect the population data for the overall data set or a portion of the data set, this adjustment should be explicit.

1.4.1 Level 4 – Flowcharts

Below is the Level 4 principle flowchart. The subsequent flowcharts give additional detail for each segment.

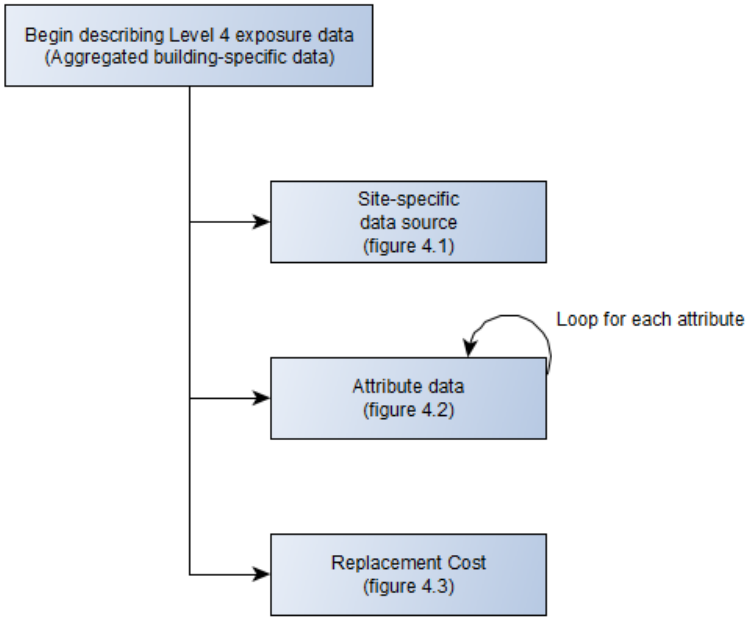

Figure 1.4.1: Level-4 principle flow chart.

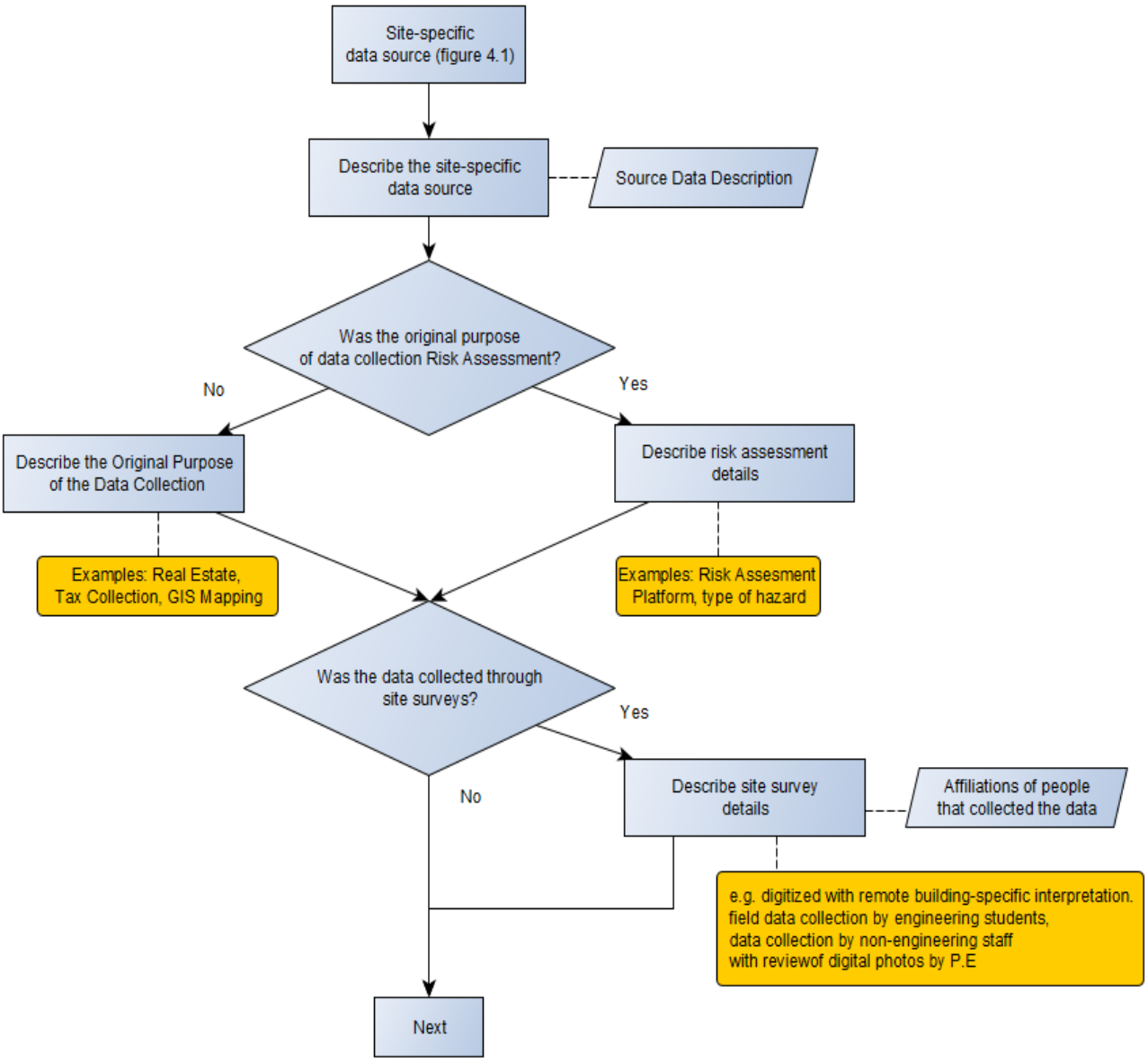

Figure 1.4.2: Flowchart for determining the how to use site-specific data.

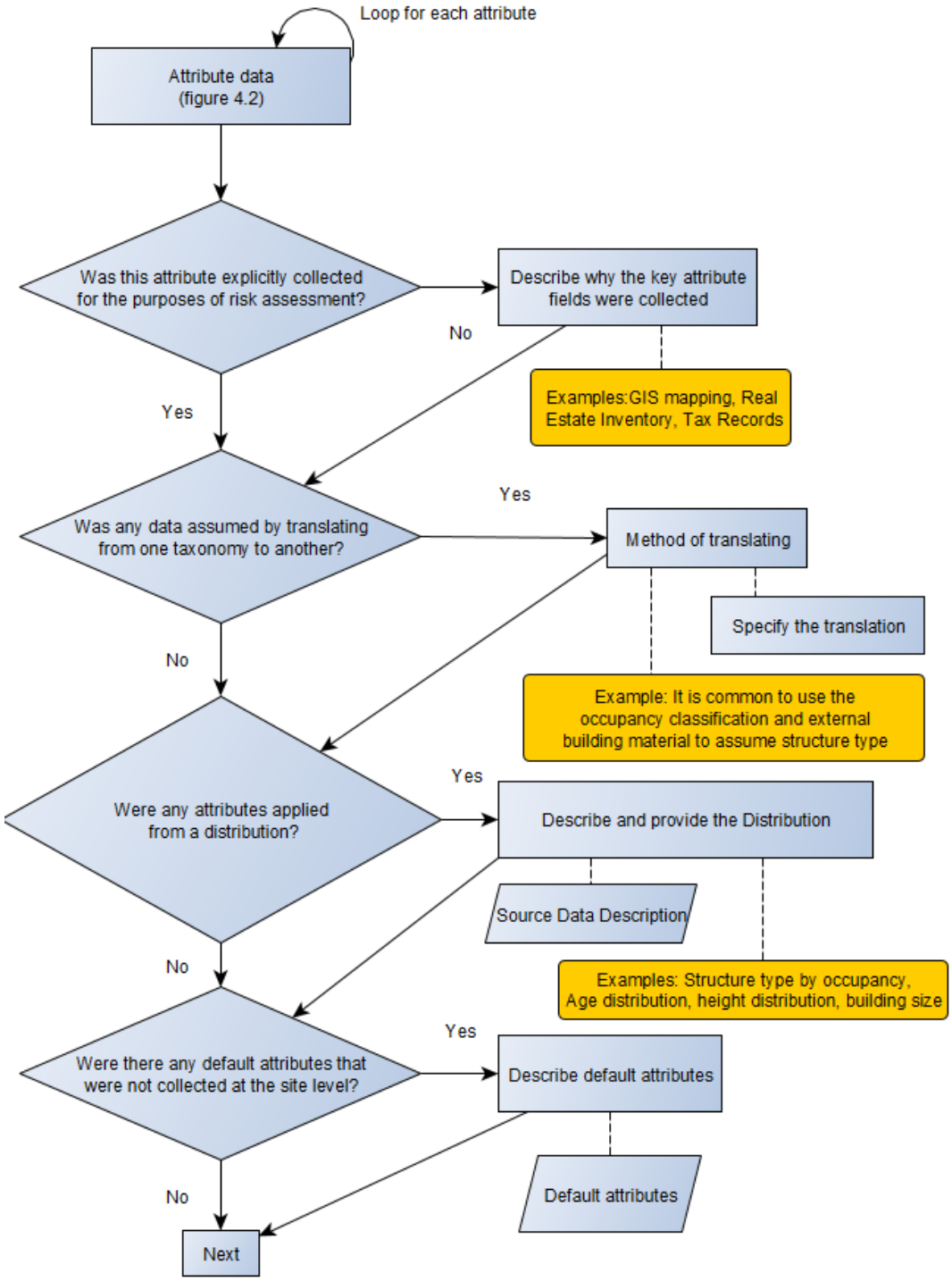

Figure 1.4.3: Flowchart for determining information regarding the feature attribute data.

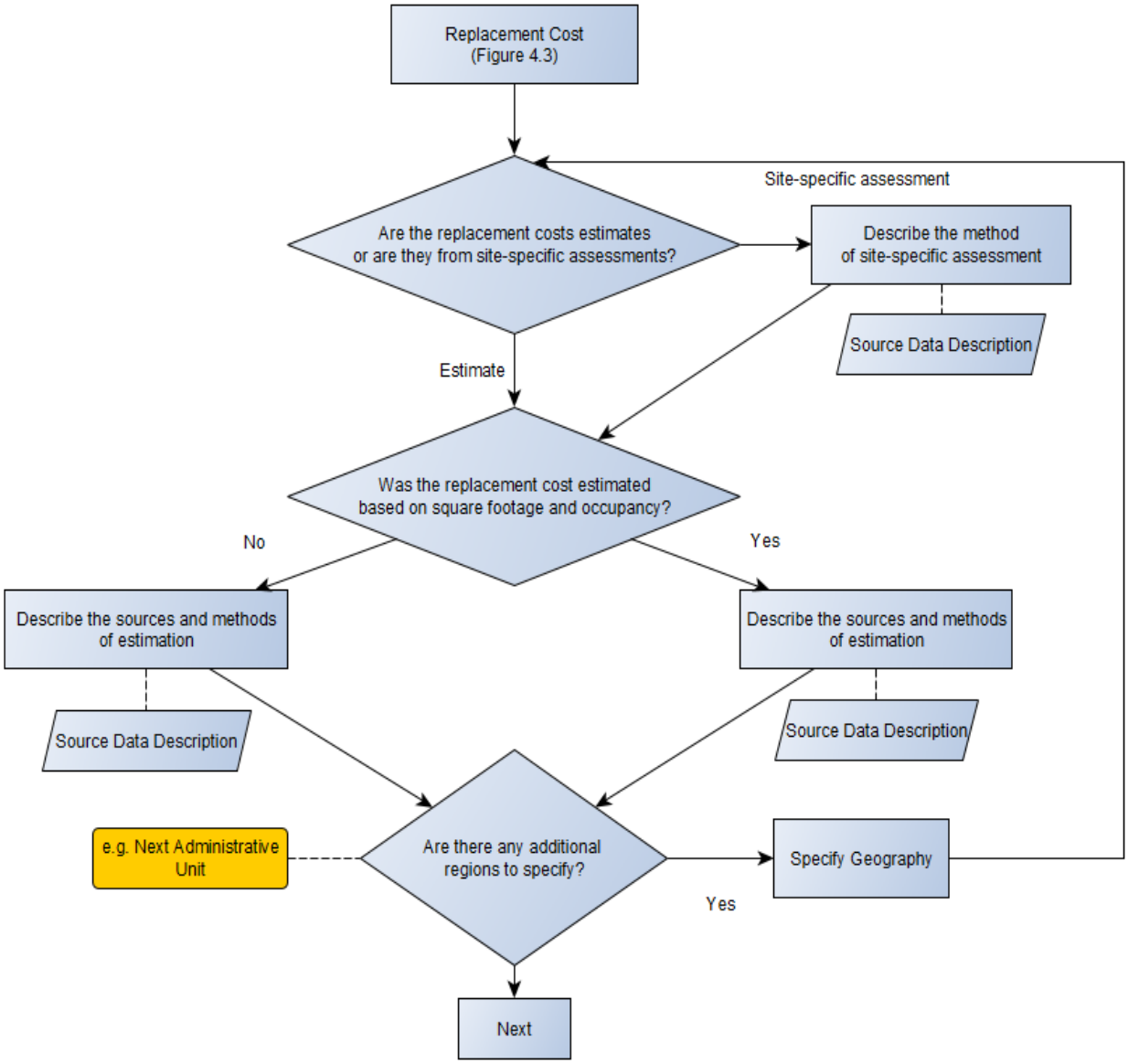

Figure 1.4.4: Flowchart for determining total replacement cost.

1.5 Level 5 – Site-specific Data

Site-specific data is presumably the most accurate data available. However, even with site-specific data, there are often key decisions that need to be made when collecting or processing the data and these decisions need to be documented and described. The key difference between Level 4 and Level 5 is the aggregation of the data. The decision as to whether or not to aggregate the data is informed by attribute data availability, processing resources, privacy, and other considerations. It is important to understand if and how the Level 5 data has been augmented or anonymized for the purposes of risk assessment in order to assure appropriate use.

Site-specific data source: The users should know the source of the data, and the original purpose of data collection. If the purpose is a risk assessment, the type of hazard and software should be identified. If the data was collected through site surveys, the manner of collection should be disclosed (i.e., digitized with remote building specific interpretation by graduate students, field data collection by engineering students, data collection by non-engineering staff with review of digital photos by graduate students with structural engineering review, etc.…). Affiliations of those collecting the data (private companies, university engineering departments, local government building departments) should be acknowledged. If the data has been repurposed for risk assessment, the original purpose of data collection and the source of the data should be provided.

Vintage: Depending on the pace of development in a given area, data can rapidly become dated. At least the year of data collection needs to be provided.

Site-specific data extent: The extent of data availability needs to be explicitly defined, so that users know not only where data is included, but excluded. For example, the extent of acquisition may be limited by political jurisdictions or physical barriers unknown to potential end users who may assume that the data reaches beyond the true extent of the data collected. Even in cases where the anticipated end users of the data and those collecting the data represent the same company, agency, or organization, it is important to document the extent of coverage for posterity.

Location precision: Even at the site level, the location precision needs to be specified. It is difficult to provide accuracy in terms of a standard error but acknowledging the process of developing the site-specific data allows other users to assess suitability for hazards with highly localized variation. Whether the data was 1) geocoded, 2) digitized from satellite or aerial imagery, or 3) the data was acquired through GPS, will all impact the suitability of the data for various purposes. If the data was geocoded, the street database or platform used is useful information. The actual geocode, or accuracy of location for each individual building, can help resolve problems such as mislocation of critical facilities without street references, or multiple locations at city centres. If data is digitized from imagery as building footprints, or polygons representing the extent of the building as it appears on the ground from the air, the data might not be able to be processed in most risk assessment programs as polygons. A point location is likely required for assessment and depending on the size and orientation of the footprint, the difference in elevation between the centre of the polygon and the portion of the building with the lowest elevation may impact calculations of loss associated with flooding, coastal surge, sea level rise, or tsunami exposure. For coordinates extracted from polygons, it should be specified whether the point represents the front door to the building, geometric centre, internal centre, or some other location. If the data is considerably older than the date the images were published, the date and source of the imagery should be included in the metadata. If the data is acquired through GPS, commonly paired with other field collection data such as attribute interpretations and aerial photos, the location may represent a location where a given photo was taken across the street. Any limitations associated with the GPS coordinates should be acknowledged. For example, elevation from GPS is seldom accurate, and

GPS locations can be erratic in urban canyons or mountainous regions. The projection and datum of the data should be common to avoid translation errors or excessive end-user interpretation.

Attribute data: For data that is not explicitly collected for the purposes of risk assessment it should be clear how the key attribute fields were collected, including the occupancy, structure type, year built, and number of stories. If data has been assumed by translating from one taxonomy to another, the nature of that translation should be explicit. For example, it is common to use the occupancy classification and external building material to assume structure type. If there are default attributes that were not collected at the site level, such as building height, this needs to be explicit. If attributes have been simulated using a sampling strategy by, for example, using mapping schemes to infill structure type at the site level, the details of the process should be provided.

Replacement cost: The basis for assigning the replacement cost should be documented, as with all levels. Typically the replacement cost will be estimated based upon the square footage and occupancy, and as with these sources the original source of exposure data should be referenced. Even though the same methods may be used, since the replacement cost estimates are site-specific, it is easy for users to mistake the values for site-specific assessments, rather than estimates based on mean construction costs. As with all data provided as site-specific data, it is important to highlight data that is assumed or modelled so that the accuracy is clearly understood.

Limitations: Given the discussion above, it is ideal to note the issues involved in having site-specific data together in one place in a limitations section. Even if end users do not completely review the documentation, the limitations are likely to be seen.

Essential Facilities: Site-specific essential facilities are typically included along with Level 3 and Level 4 data but are typically broken out from the general building stock and delivered as site-specific Level 5 data. What essential facilities are collected are based on the project requirements. Unless there is a centralized government agency with jurisdiction over collecting, collating, and managing a given attribute, it is difficult to obtain complete data. For facilities that are managed at the state or local level, a complete list is more difficult to obtain. For example, schools, emergency facilities, and hospitals may be more challenging than roads, bridges, and government buildings. Even when a centralized government agency aggregates the data, it might be incomplete in some districts. It is advisable to test the completeness of the final data set by comparing the number of facilities by district with population and assuring the numbers are relatively consistent by county. Where large numbers are missing, it may be feasible to simulate the location of facilities using population data, but it is important that the purpose of this data is understood. The sources of data collected, as well as the geocoding resolution (city, postal code, address, precise location), are important to document. When a layer is aggregated from multiple sources, the source of each facility and the resolution of each facility should be noted for every row in the table. If it is possible to estimate the total number of facilities, even those without data collected, this information should be provided and sourced.

1.5.1 Level 5 – Flowcharts

Below is the Level 5 principle flowchart. The subsequent flowcharts give additional detail for each segment.

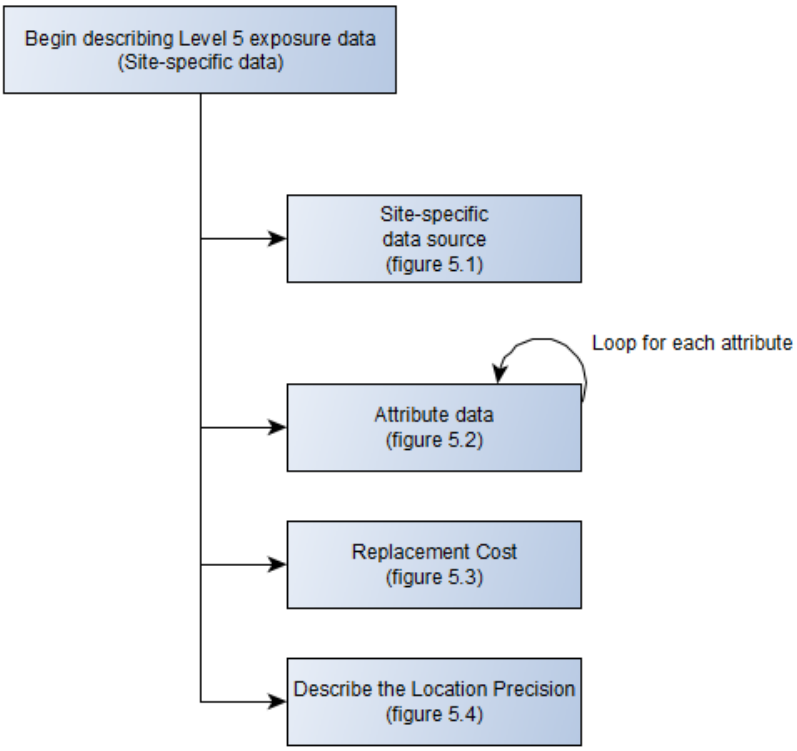

Figure 1.5.1: Level-5 principle flow chart.

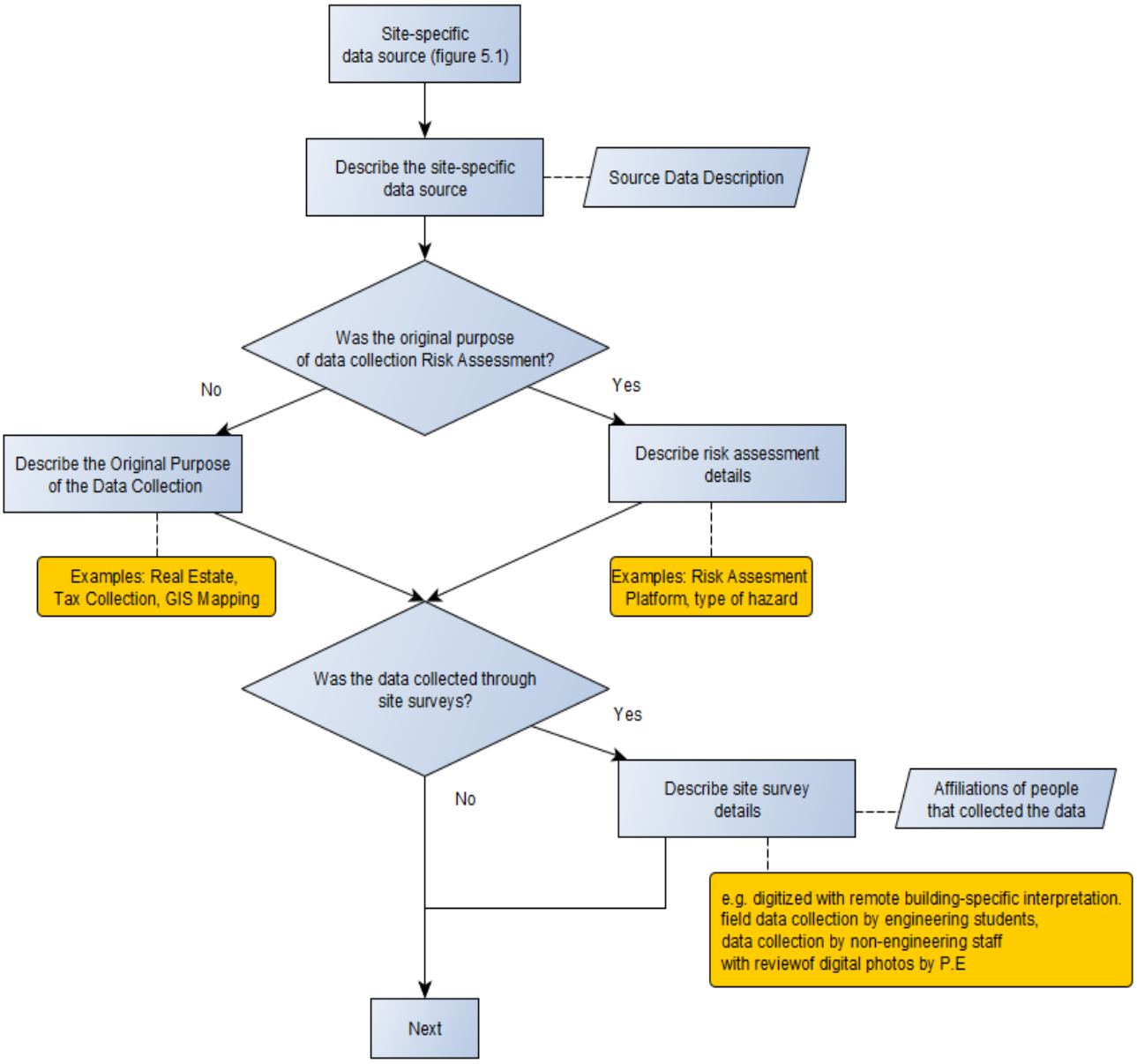

Figure 1.5.2: Flowchart for determining the how to use site-specific data.

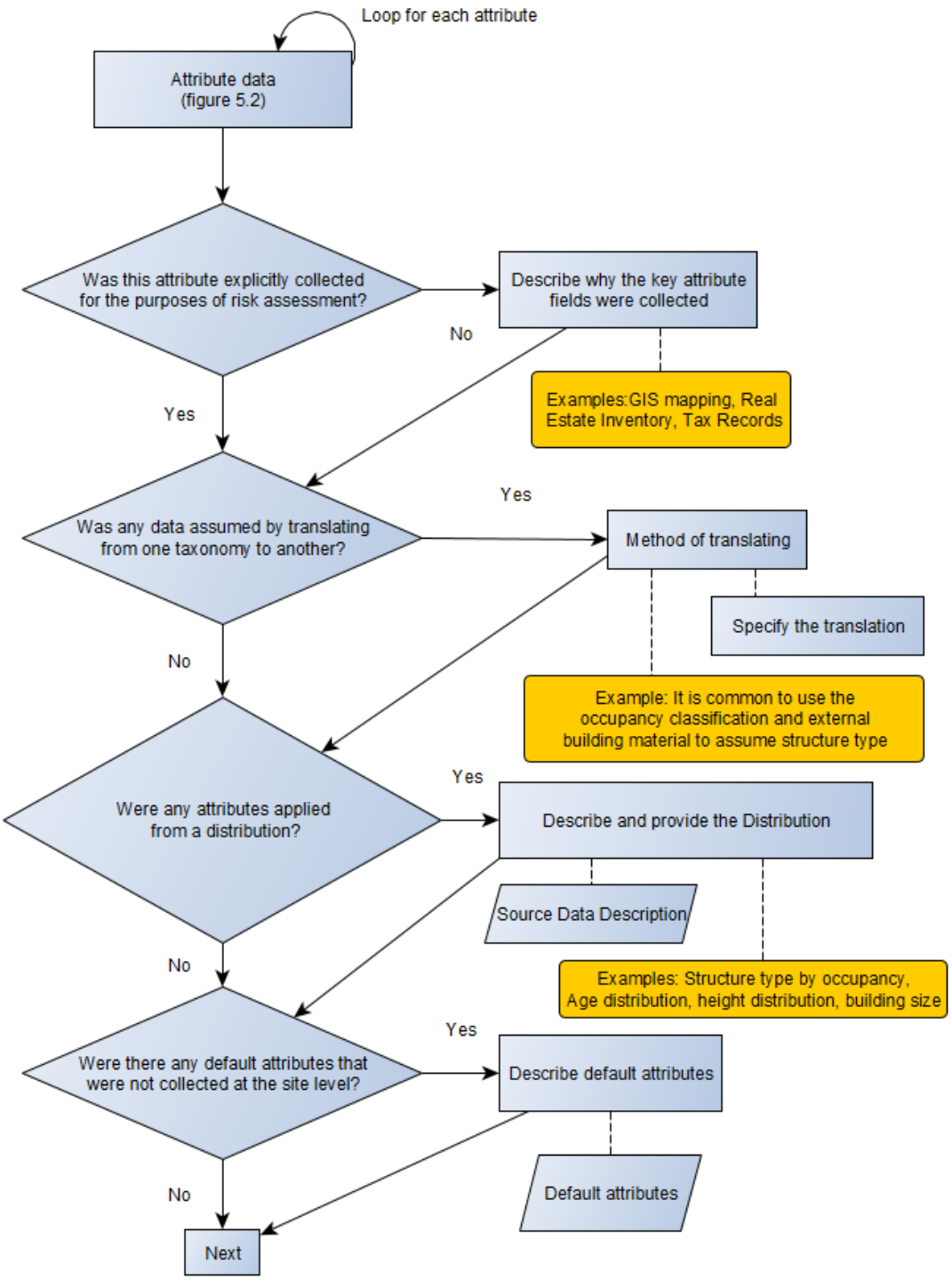

Figure 1.5.3: Flowchart for gathering information regarding the feature attribute data.

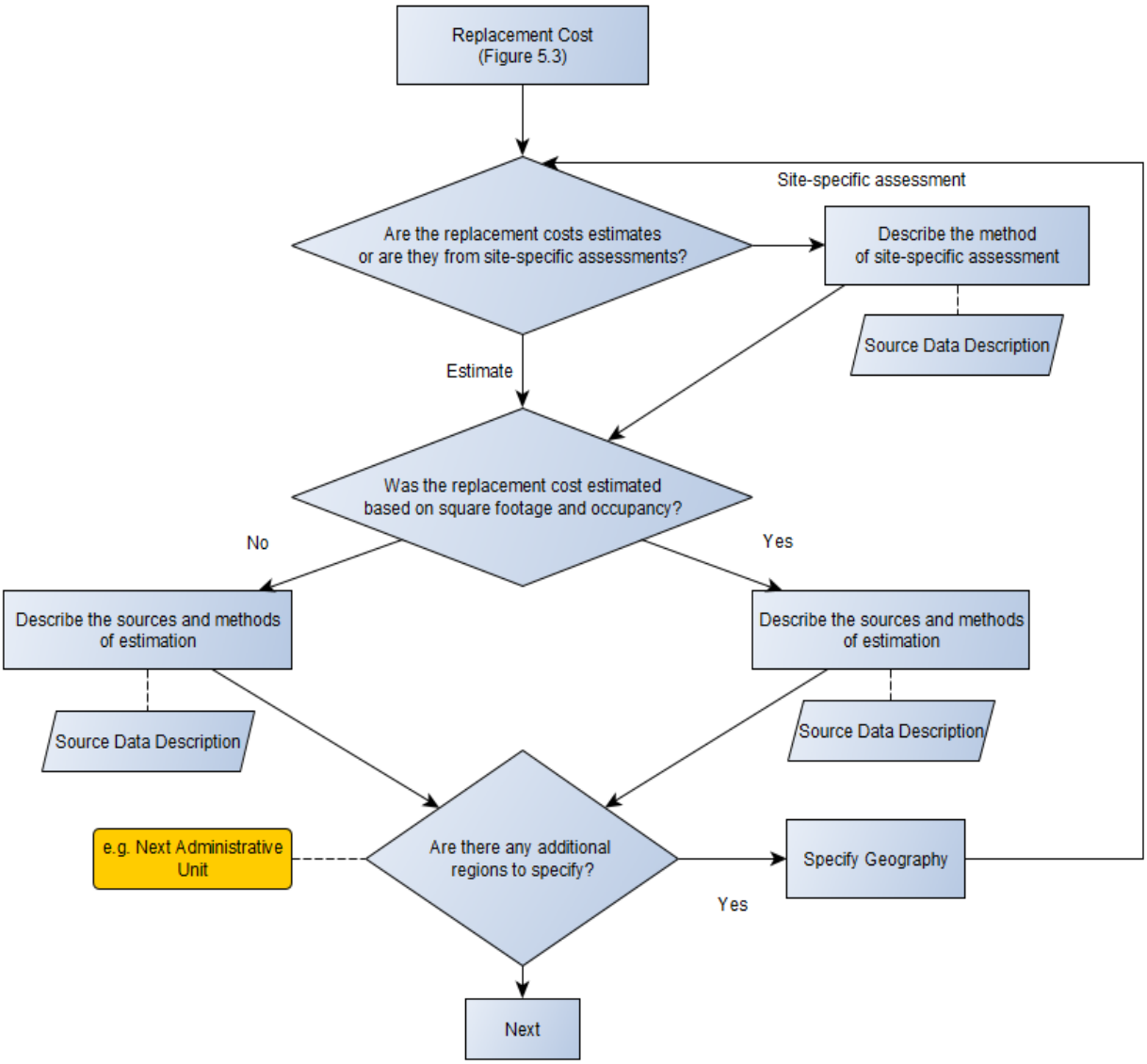

Figure 1.5.4: Flowchart displaying the path for calculating replacement cost.

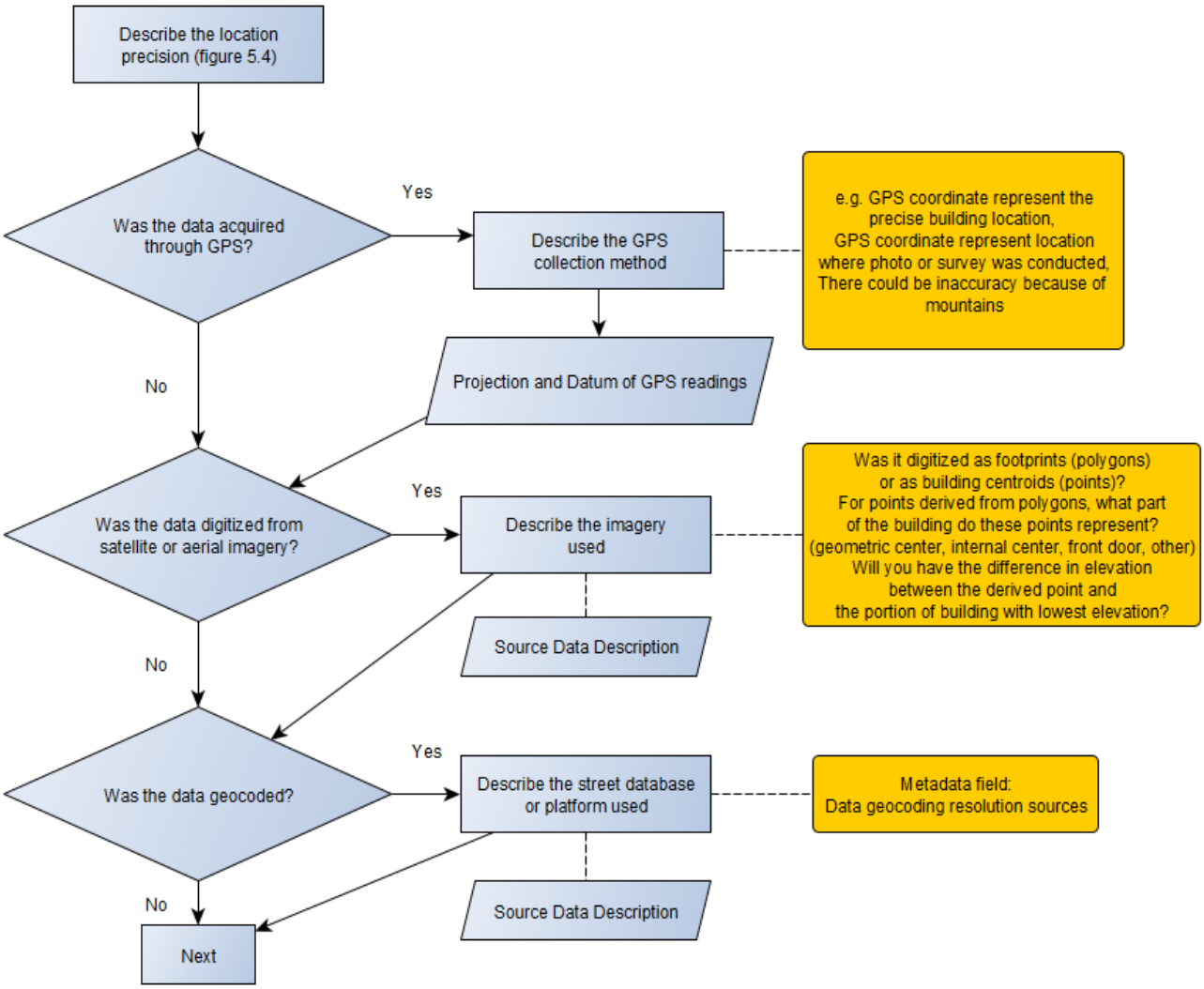

Figure 1.5.5: Feature location flowchart.