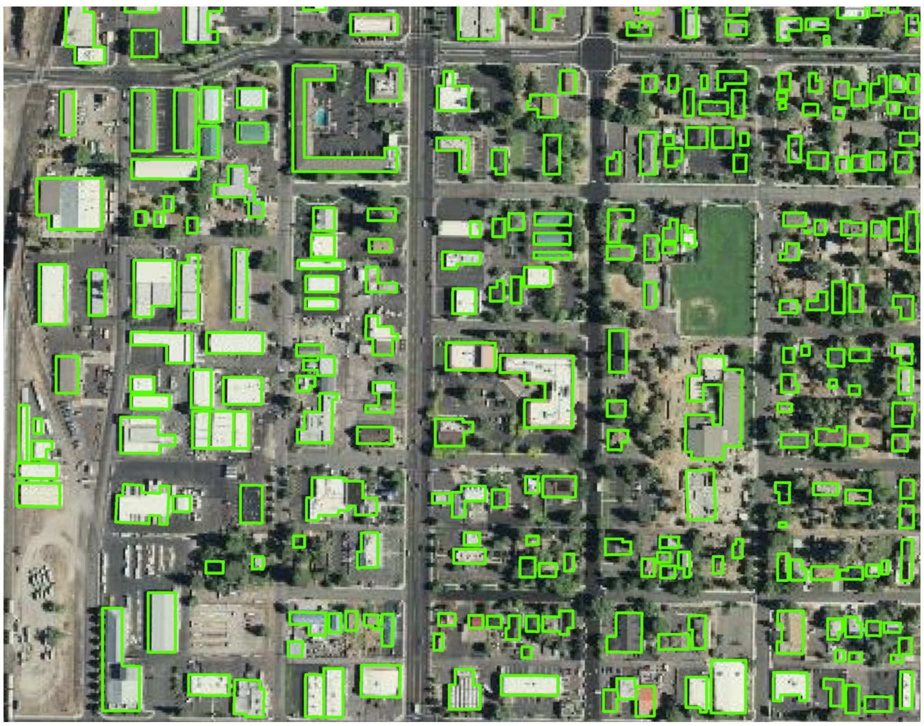
State of Oregon
Oregon Department of Geology and Mineral Industries
Brad Avy, State Geologist

DIGITAL DATA SERIES

STATEWIDE BUILDING FOOTPRINTS FOR OREGON, RELEASE 1.0

by Matt C. Williams[1]



2021

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WHAT'S IN THIS PUBLICATION?

This report describes the compilation of a statewide database of building footprints for Oregon. The many potential uses for this digital resource include hazard risk assessment, natural hazard preparedness, emergency planning and response, emergency evacuation, land use planning and development, asset management, real estate interests, and general cartography.

Cover image: Statewide Building Footprints for Oregon layer (green) in a portion of the City of Bend. The basemap image is from the Oregon Statewide Imagery Program (2018).

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GEOGRAPHIC INFORMATION SYSTEMS (GIS) DATA

See the digital publication folder for files.
Geodatabase is Esri® version 10.7 format. Metadata is embedded in the geodatabase and is also provided as separate .xml format files.

Statewide_Building_Footprints.gdb:
feature class:
SBFO_2021_1 (polygons)

Metadata in .xml file format:
SBFO_2021_1_metadata.xml

ABSTRACT

Building footprint data, two-dimensional representations of building outlines as seen from above, can be used in many ways for geospatial and cartographic purposes. Natural hazard preparedness and risk assessment, emergency planning and response, land use planning and development, asset management, real estate interests, and general cartography are some of the activities that are supported by building footprint data. In 2018 Microsoft Corporation mapped building footprints for the entire United States and made them publicly available via the open-source website GitHub. Through funding from the Oregon Geospatial Enterprise Office (GEO), DOGAMI was able to use the Microsoft data and other pre-existing building footprint datasets in the state to review, edit, and compile a high-quality building footprints dataset for the entire state of Oregon.

The completed Statewide Building Footprints for Oregon (SBFO) is a compilation of contributed datasets from city, county, and state agencies, regional planning organizations, and open-source groups. The building footprint datasets were derived by using various digitization methods and various basemap data types. The Oregon Department of Geology and Mineral Industries (DOGAMI) reviewed and edited the building footprints from the contributing sources to achieve consistency within the compiled statewide dataset. The total number of features in the first release of the SBFO dataset is 2,171,335.

1.0 INTRODUCTION

Buildings throughout Oregon provide a wide range of functions for people. Digital building inventories can be useful and versatile datasets for natural hazard, emergency, and land use planning. They can also be used for asset management at local, state, and federal levels. While building inventories can be used in geospatial analysis, they can also be used as basemap layers for cartographic purposes. A building inventory is a resource in emergency response, especially for evacuation purposes. A building inventory supports many other uses, so the need for this data type is great. One type of building inventory is building footprints, which are two-dimensional representations of building outlines as seen from above.

The Oregon Geospatial Enterprise Office (GEO) funded DOGAMI to produce a statewide dataset of building footprints. DOGAMI defines a building as a permanent, walled, and roofed structure that can be occupied by a human for a duration of time. Using this parameter, DOGAMI reviewed, edited, and compiled building footprint data and created an inventory of buildings named Statewide Building Footprints for Oregon (SBFO). We recognize that some structures do not fit neatly into this building definition, so additional determinations were made for consistency in the SBFO.

The purpose of the project outlined in this report was to review and edit existing building footprint data and compile the data into a single, comprehensive, high-quality building footprint dataset for the state. Datasets that comprise the SBFO were contributed from local, county, regional planning, and state sources, as well as from an open-source Microsoft Corporation dataset. All datasets were reviewed in Esri ArcMap® 10.7 for error corrections and consistency using the Oregon Statewide Imagery Program (OSIP) 2017 and 2018 imagery (GEO, 2017, 2018) for verification. New building footprint data were generated during the review process for buildings as they appeared in the reference imagery but were not accurately represented in the building footprint data. With this publication SBFO data are publicly available for download from DOGAMI and from the Oregon Geospatial Data Library. The SBFO consists of over 2.1 million building footprints that represent the best available data within the state at the time of writing.

2.0 CONTRIBUTING BUILDING FOOTPRINT DATASETS

In 2018 Microsoft Corporation used machine-learning to automate building footprint digitization for the entire United States. This process, using Bing imagery exclusively, generated over 1.8 million buildings within the state of Oregon. The resulting 2018 dataset was called “Microsoft Building Footprints – Features” (Microsoft Corporation, 2018). We used the 2018 dataset; the current Microsoft building footprints dataset is available from the open-source website GitHub (https://github.com/Microsoft/USBuildingFootprints). In this report we call this 2018 open-source subset “Microsoft OS.” We used these Microsoft OS data for all areas in the state that did not already have high-quality building footprint data, as described below. While the Microsoft data are extremely useful, they are the lowest-quality dataset in the compilation due to automated generation of footprints.

In addition to the Microsoft OS data, datasets were contributed to DOGAMI for this SBFO project from local, county, and regional planning sources. Some datasets were not publicly available and were provided to DOGAMI upon request. Most of the datasets are regularly maintained. Contributing agencies or organizations are the City of Salem, Benton County, Jackson County, Josephine County, Linn County, and Columbia County. Building footprint data were also contributed from the Lane County Council of Governments (LCOG) and Metro (Clackamas, Washington, and Multnomah Counties) regional planning organizations. We reviewed each dataset for errors and consistency before compilation. These datasets were of high quality and required minimal amounts of editing, although differences between digitized buildings and nonbuilding structures among these data sources required DOGAMI to make some edits to achieve consistency. Another source of variability is that individual municipalities within a county may generate building footprints to append to a countywide dataset. In this case the larger entity acts more as a data curator than a data creator. Datasets maintained by local, county, and regional planning sources made up 80% of all building footprints in the SBFO.

DOGAMI contributed datasets produced from prior projects that required building footprint data. Most of these datasets were derived from lidar sources but were generated to meet specific project-based purposes so are of variable quality depending upon methods, data vintage, and basemap information. No maintenance has occurred on DOGAMI’s datasets since they were originally generated. Some DOGAMI building footprints datasets are over 10 years old and no longer adequately reflect the real world. The counties that DOGAMI contributed building footprints for were Clackamas, Clatsop, Columbia, Coos, Douglas, Harney, Hood River, Lane, Lincoln, Multnomah, Polk, Sherman, Tillamook, Wasco, Washington, and Yamhill. DOGAMI-generated building footprints for coastal counties were limited to the coastal margin for use in tsunami hazard mapping projects. Not including the building footprints that were incorporated into the LCOG (Lane County) and Metro (Clackamas, Multnomah, and Washington Counties) datasets, DOGAMI contributed 244,661 building footprints to the SBFO.

Figure 3-1 shows primary building footprint data sources. Additional details regarding the datasets are provided in **Figure 3-1**. Building counts from the compilation sources are shown in **Figure 3-1**. Additional details regarding individual datasets are provided in **Figure 3-1**.

Figure 2-1. SBFO building footprint primary data sources by county or city.

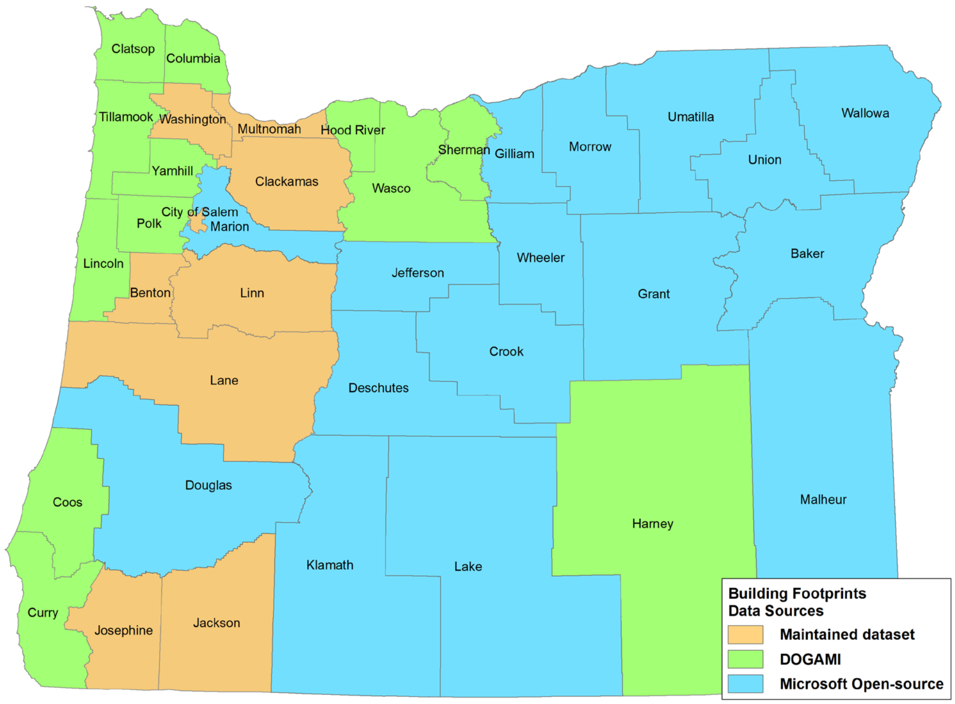


Table 2-1. SBFO datasets from local, county, and regional planning sources

Organization	Vintage of Contributed Dataset	Approximate Maintenance Frequency	Digitization Mode
Benton County	2019	annually	manual
Columbia County	2018	static	manual
Jackson County	2019	monthly	manual
Josephine County	2018	monthly	manual
Linn County	2021	quarterly	manual and lidar extraction
LCOG	2020	quarterly	various
Metro	2020	quarterly	various
City of Salem	2019	annually	manual

LCOG is Lane County Council of Governments. Metro is the regional government for the Oregon portion of the Portland metropolitan area.

Table 2-2. SBFO building footprint totals by dataset contributor.

County Name	Building Footprint Data Contributor	Original Building Footprint Count
Baker	Microsoft OS	15,910
Benton	County GIS	54,732
	Microsoft OS	1,457
Clackamas	Metro	204,215
Clatsop	DOGAMI	23,719
	Microsoft OS	23,877
Columbia	County GIS	28,925
	DOGAMI	8,162
Coos	DOGAMI	45,047
	Microsoft OS	39,579
Crook	Microsoft OS	17,542
Curry	DOGAMI	19,167
	Microsoft OS	15,675
Deschutes	Microsoft OS	97,118
Douglas	DOGAMI	4,330
	Microsoft OS	66,751
Gilliam	Microsoft OS	2,955
Grant	Microsoft OS	8,173
Harney	DOGAMI	4,777
	Microsoft OS	7,736
Hood River	DOGAMI	13,611
	Microsoft OS	12,311
Jackson	County GIS	176,188
Jefferson	Microsoft OS	15,850
Josephine	County GIS	57,057
Klamath	Microsoft OS	46,607

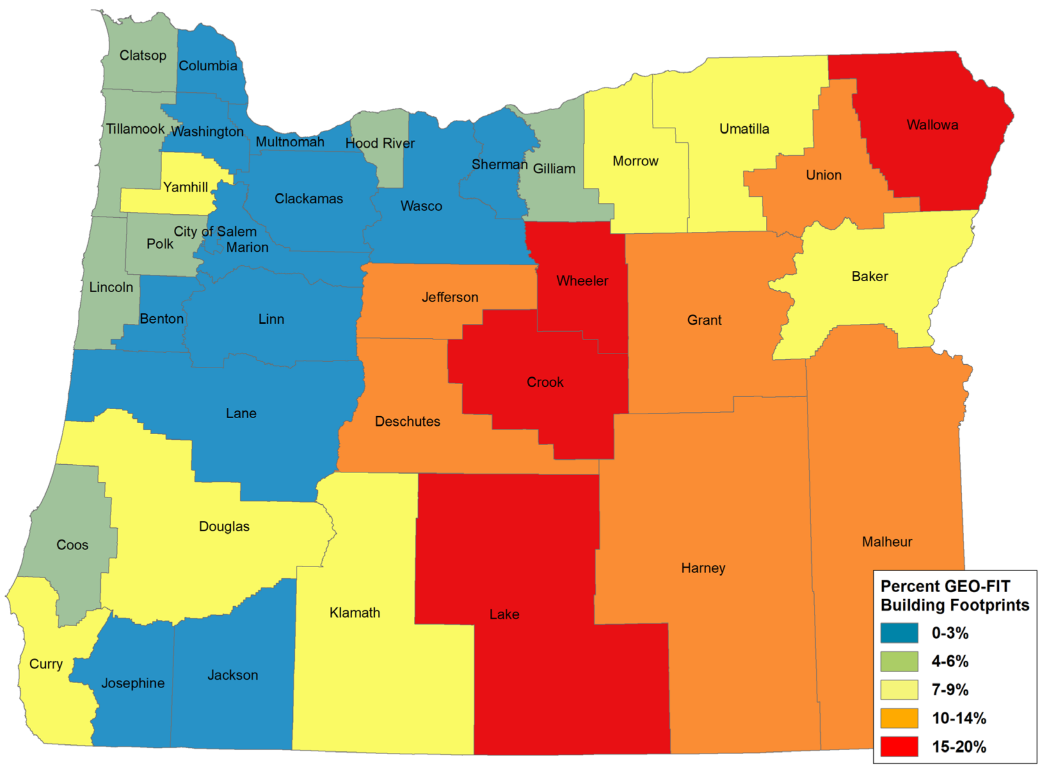
County Name	Building Footprint Data Contributor	Original Building Footprint Count
Lake	Microsoft OS	9,221
Lane	LCOG	167,205
	Microsoft OS	33,696
Lincoln	DOGAMI	34,336
	Microsoft OS	32,740
Linn	County GIS	93,823
Malheur	Microsoft OS	20,236
Marion	City of Salem	108,137
	Microsoft OS	60,919
Morrow	Microsoft OS	9,078
Multnomah	Metro	300,270
Polk	City of Salem	11,550
	DOGAMI	40,043
	Microsoft OS	8,450
Sherman	DOGAMI	2,578
	Microsoft OS	2,764
Tillamook	DOGAMI	26,805
	Microsoft OS	22,424
Umatilla	Microsoft OS	41,388
Union	Microsoft OS	18,009
Wallowa	Microsoft OS	8,578
Wasco	DOGAMI	16,358
	Microsoft OS	17,752
Washington	Metro	232,692
Wheeler	Microsoft OS	2,504
Yamhill	DOGAMI	5,728
	Microsoft OS	48,743

Microsoft OS is the open-source building footprint dataset created by Microsoft Corporation. LCOG is Lane County Council of Governments. Metro is the regional government for the Oregon portion of the Portland metropolitan area.

3.0 NEW DATA

As part of its data quality review, DOGAMI overlaid contributed footprint polygon datasets on OSIP 2017 and 2018 high-resolution aerial imagery (GEO, 2017, 2018) and made edits as needed. New data were generated through digitization where no building footprint was present, where the building outline was completely misrepresented, or where merged building footprints needed to be split apart. Nearly all new digitization occurred outside areas of maintained building footprint data extents (**Figure 3-1**). It was necessary to generate new building footprint data to achieve a comprehensive, high-quality dataset across the entire state. DOGAMI generated 71,424 new building footprints. In the geodatabase the contributor [CONTRIBUTOR] field was attributed with "GEO-FIT" for all new building footprints generated during this project. Counts for GEO-FIT attributed building footprints are shown in Appendix C.

Figure 3-1. Percentage by county of new building footprints generated after comparing contributed datasets with high-resolution aerial imagery (GEO, 2017, 2018). New footprints were attributed in the geodatabase as "GEO-FIT."



4.0 METHODOLOGY

DOGAMI used the methods described below to generate the SBFO, release 1.0:

1) Identify existing building footprints within each county and prepare the datasets for review.
2) Assess the quality of each dataset, deleted errors, and digitize new building footprints.
3) Create a data structure of attributes to meet the various data needs of building footprints.
4) Compile all the completed countywide datasets into a single statewide dataset.

These methods resulted in a single feature class of polygons representing building footprints.

4.1 Compilation by county

The initial steps of the project were to identify existing building footprint datasets within the state. Inquiries were made to individual counties and cities to locate and gather any maintained building footprint datasets. Additional information was gathered at this time to understand perspectives regarding building versus nonbuilding structures, building footprint size limitations, frequency of updates, and digitization methods. DOGAMI obtained the maintained datasets via a publicly available web page or an FTP transfer provided by the data contributor. Each of the contributed datasets were stored in individual geodatabases organized by county.

Building footprint datasets created by DOGAMI were stored on internal DOGAMI servers and imported into their respective county geodatabases. Over the past 10 years DOGAMI has digitized buildings in many areas within the state to fulfil needs of specific projects. These inventories were static, meaning no maintenance was intended post-project. While the DOGAMI data represent the best available building footprints for many areas in the state, the quality of these datasets is highly variable, primarily due to lack of maintenance.

The Microsoft OS building footprint data were also clipped according to county boundary areas and imported into their respective county geodatabases. For some counties that had existing building footprint data, the Microsoft OS data acted as supplemental data coverage. In other counties, the Microsoft OS data were unnecessary because of the level of quality of the existing maintained data. In many counties the Microsoft OS data were the only source of data available. In order to locate added and removed building footprints where Microsoft OS was the only data source (mostly rural counties), we ran an error assessment. On average, we found a 6.3% error of commission and a 13% error of omission for these counties (**Table 4-1**).

If a county geodatabase contained more than one dataset, we merged the datasets into a new dataset with the existing maintained data and DOGAMI data taking priority over Microsoft OS data. By prioritizing this way, the Microsoft OS data were used to fill in gaps where buildings had been omitted in the other datasets. This was done by selected the non-intersecting Microsoft OS building footprints and importing them, along with the other existing data, into a newly merged dataset. We then added the newly merged dataset to ArcMap for review and edits. For counties with a single-sourced building footprints dataset, the merging step was unnecessary.

Table 4-1. Microsoft OS building footprints error assessment by county. This assessment was conducted only for counties where the sole source of building footprint data was Microsoft OS.

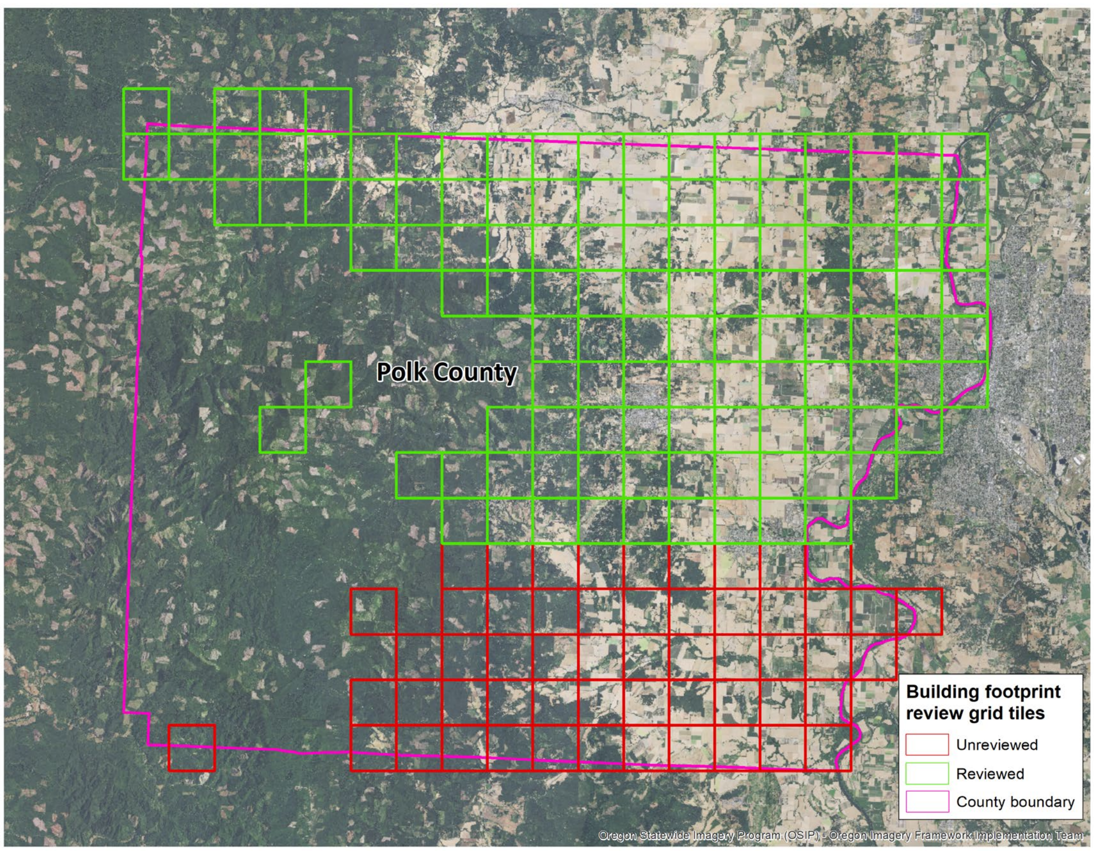
County	Original Count	Count Deleted	Commission Error Rate	Count Added	Omission Error Rate
Baker	15,910	959	6.0%	1,110	7.0%
Crook	17,542	1,419	8.1%	3,209	18%
Deschutes	97,118	3,363	3.5%	14,466	15%
Gilliam	2,955	459	16%	150	5.1%
Grant	8,173	512	6.3%	1,254	15%
Jefferson	15,850	1,529	9.6%	2,213	14%
Klamath	46,607	2,019	4.3%	3,368	7.2%
Lake	9,221	1,091	12%	2,012	22%
Malheur	20,236	2,192	11%	2,832	14%
Morrow	9,078	1,301	14%	597	6.6%
Umatilla	41,388	2,432	5.9%	2,813	6.8%
Union	18,009	764	4.2%	2,898	16%
Wallowa	8,578	667	7.8%	1,800	21%
Wheeler	2,504	254	10%	466	19%
Total	297,259	18,961	6.3%	39,188	13%

4.2 Review and digitization

We used the same data preparation and setup, reference basemap imagery, review scale range, digitization scale range, and building footprint parameters throughout the entire review and digitization process. Exceptions were made for the following counties: Columbia, Clackamas, Jackson, Josephine, Linn, Multnomah, and Washington, because after a cursory review, the datasets were assessed to contain few errors and were consistent with the data standard defined by the SBFO. The entire process was conducted using ArcMap 10.7.

DOGAMI set up the review process by first creating an index grid based on the county extent. The index grid was composed of 9,500 ft × 9,500 ft tiled grids that encompassed the entire county. The index grids that did not contain building footprints were removed. An integer field called "reviewed" was added to the attribute table of the index grids and populated with the attribute "0." We were able to track our review progress by changing this attribute to "1" after review of the grid tile was complete. **Figure 3-1** shows an example of how a county is set up for building footprint review.

Figure 4-1. Example of building footprint review of Polk County using grid tiles. Portions of the county with no grid overlay did not contain building footprints.



We used the OSIP 2017 and 2018 imagery (GEO, 2017, 2018) as basemap layers to identity and verify outline building outlines. The merged county building footprints were symbolized by an outline to allow the basemap image to be seen under the building footprint. We visually inspected the building footprints within a grid tile at a scale of 1:3,000 to 1:6,000 depending on building density. If a building appeared on the basemap imagery and was undigitized or misrepresented, we first determined if it was a structure that met our definition of a building. If it was a building, we edited a new building footprint to match the outline as it appeared on the basemap imagery. We digitized building footprints at a scale range of 1:800 to 1:1000.

Every grid tile was carefully scanned, by slowly panning within the tile at review scale back and forth until the entire tile was visually inspected. We identified undigitized buildings through interpretative photogrammetry using high-resolution orthoimagery (GEO, 2017, 2018). This was a skill set developed over time and was essential in identifying errors in the building footprint datasets. We also implemented the parameters of our building definition to determine whether structures were included or excluded (see Appendix A for examples). This process took into consideration the size limitation of 100 square feet (9.3 square meters), so that very small structures were not digitized.

We also removed the following nonbuilding structure types present in some pre-existing datasets:

- hoop-houses or plastic-covered greenhouses,
- types of infrastructure (dams, water tanks/towers, electric transmission, sewage and water treatment processing structures),
- tents, awnings, and carports,
- small garden/storage sheds,
- structures on manufactured home dealership lots,
- grain silos

Most building footprints were digitized using the Rectangle tool to ensure right-angled polygons. Buildings with more than four sides were digitized with multiple rectangles and then merged into a single polygon. Separate buildings that displayed as merged into a single polygon were split into the appropriate number of polygons. This typically occurred in downtown areas where buildings can share a common wall. No attribution occurred during the digitization phase of the project.

4.3 Attributes

The associated attributes of the building footprint dataset provide additional information about individual buildings. The fields that contain the attributes are designed to best address the potential uses of the data and to facilitate data maintenance over time. Building footprint data are intended to serve a variety of functions, so the attribute fields must reflect this characteristic. Needs and functionality can shift across the entire state, so the data structure must be applicable to this extent. Updates will be necessary in the future, so considerations regarding data structure design during database creation can ease this process.

Each building footprint feature was identified by a unique code, with the field name [ORBLD_ID]. The code is composed of a hyphenated county number, followed by a number that is unique to the county within which the building footprint is located. The county number is based on the sequential alphabetical order of the county name. The unique number relative to each county is a seven-digit number. This number was originally created by adding "100000" to the [OBJECTID] value that is autogenerated in every ArcGIS geodatabase.

Other attributes are site-specific information or are based on characteristics of the building. These include attributes that describe some building dimensions. Where available, the dataset contains the year of construction of the building, which is derived from taxlot data.

Another group of attributes is related to dataset maintenance. These attributes describe data source, digitization methods, data contributors, and date of last review. These attributes are important for accuracy and dataset updates. See **Table 4-2** and **Figure 3-1** for attribute descriptions.

Table 4-2. Building footprint attributes.

Field	Description
ORBLD_ID	Unique identifier for the building footprint feature.
COUNTY	Name of county that the centroid of the building footprint occurs.
CONTRIBUTOR	Entity that contributed building footprint data.
SOURCE	Name of imagery, lidar, cad drawing, etc. used to generate building.
SOURCE_TYPE	Type of imagery, lidar, cad drawing, etc. used to generate buildings.
SOURCE_DATE	Vintage of imagery, lidar, cad drawing, etc. used to generate building.
LAG	Lowest adjacent grade or minimum elevation above sea level of the building.
ROOF_MEAN	Average height in feet above the ground within building footprint.
ROOF_MAX	Maximum height in feet above the ground within building footprint.
YEAR_BUILT	Year built of buildings derived from the taxlot information.
SQ_FT	Area of the building footprint in feet.
REVIEW_IMG	The name of the imagery used during the most recent inspection.
REVIEW_IMG_YEAR	Vintage of imagery used during the most recent inspection.
REVIEW_DATE	Most recent date of data inspection.

4.4 Statewide compilation

The final step in creating the SBFO was compiling all the completely reviewed and edited countywide datasets into a single statewide dataset. All the countywide datasets had identical field names and settings, so the datasets appended seamlessly. All appended records in the SBFO are unique because each footprint identifier has a leading hyphenated county code in the ORBLD_ID field.

One concern while merging the countywide datasets was correcting redundant or overlapping polygons, which occurs mostly at county boundaries. These errors were fixed by using the topology tool in ArcMap. A topology was created with the rule of no overlaps for the building footprints. The topology check for the entire state resulted in over 3,300 buildings with overlapping polygons. We opted to merge polygons that overlapped into single polygons, where the building centroid determined the county and unique identifier attribute. Due to limited time and funding this was the best option for reducing this type of error.

The final SBFO dataset is stored in a file ArcGIS 10.7 geodatabase. It contains over 2.1 million building footprints. The data are projected in the statewide projection — Oregon Lambert.

5.0 RESULTS AND DISCUSSION

This project resulted in SBFO, release 1.0, covering the entire state of Oregon and representing the best available building footprint data for the state at the time of writing. This is a comprehensive dataset that provides greater consistency and accuracy across the state by compiling datasets from local, county, state, regional planning agencies, and open-source data providers. Contributors are the City of Salem, Benton County, Columbia County, Linn County, Jackson County, Josephine County, Metro, LCOG, DOGAMI, and open-source data from Microsoft Corporation. In addition to the pre-existing datasets compiled, over 71,000 building footprints were digitized through this project and incorporated into the SBFO following the methods described in this report. The total number of building footprints in SBFO, release 1.0 is 2,171,335.

In addition to the compiled data, new building footprints were created for every part of the state. Counties that had only open-source Microsoft data required most of the new digitization. This was especially true for counties such as Deschutes County that also had a high degree of development in the past 5 to 10 years. The results suggest that building footprint data quality is highly dependent upon regular maintenance.

The results also indicate that automated building footprint digitization is more accurate with lidar-derived DEMs than from orthoimagery, as was used to produce the Microsoft data. This was inferred from the level of accuracy of some of the unmaintained DOGAMI building footprints compared to the Microsoft OS data. However, some accuracy differences can be attributed to the age of the basemap source information and data review that occurred at the time of initial creation for some of the DOGAMI building footprints. **Figure 3-1** contains a county-based assessment of datasets through the review and edit process.

6.0 LIMITATIONS

The SBFO is a compilation of datasets that were generated by several different sources. To a certain degree, each of these sources used different methods, different building interpretations, and varying levels of data maintenance. Inconsistencies occurred across the contributing datasets. Minimizing inconsistencies was one of the primary goals of this project, but some errors remain due to developing data composed of a massive number of features.

As is apparent from assessing the contributed datasets, maintained datasets are of much higher quality than static datasets. This is because development is a constant phenomenon and keeping the building footprint data in alignment with reality is extremely difficult. The last review date for individual datasets is often indicative of the quality. Factors that slow down or inhibit data maintenance are:

- Quantity of buildings makes review and edits very time consuming.
- Buildings are constantly being built and destroyed.
- Building footprint digitization relies on high-resolution aerial imagery or lidar imagery, making updates infrequent and expensive.

Building footprint digitization is dependent upon photo interpretation, and human perception is a factor in identifying structures in aerial imagery. Photo interpretation is a skill that takes time to develop; some building footprint reviewers are more skilled than others. Building structures can be hard to distinguish in some imagery. Tree coverage limits visibility and can hinder the digitization process.

Many of the attributes were not available for every building footprint. A building's roof height and lowest ground elevation were derived from lidar, and state lidar coverage is incomplete. Also, taxlot data were unavailable for some counties, and other counties with taxlot data did not supply the year of building construction. We were unable to obtain the YEAR_BUILT attribute from taxlot data for building footprints in counties without this information.

7.0 RECOMMENDATIONS AND UPDATES

Data maintenance is important to sustaining the accuracy and relevance of the SBFO. Without an ongoing mode to update the SBFO it could quickly decline in quality. DOGAMI will coordinate with GEO-FIT program participants to ensure that data maintenance is occurring as new building footprint data become available. In part, this coordination effort will connect with building footprint data contributors throughout the state for potential updates. We recommend that updates to the SBFO occur at least annually.

Another potential opportunity for updates would be when new imagery or lidar becomes available for the state. As time and funding is available, the methods described in this report can be implemented to generate new building footprints. The vintage of source imagery or lidar is strongly correlated to the quality of the building footprints derived from it. Post-disaster mapping after a wildfire is one example of an opportunity when new mapping could occur.

8.0 POTENTIAL USES OF BUILDING FOOTPRINT DATA

The uses of building footprint data are numerous and meet various needs in both the public and private sectors. Building footprint data are versatile and integrate well with other associated datasets. DOGAMI typically uses building footprint data as a means of quantifying risk from natural disasters. Several uses for building footprints have become more evident through the course of this project. Some potential uses of the SBFO are:

- Hazard risk assessment
- Natural hazard preparedness
- Emergency planning and response
- Emergency evacuation
- Land use planning and development
- Asset management
- Real estate interests
- General cartography

9.0 ACKNOWLEDGMENTS

The Oregon Geospatial Enterprise Office provided the funding for this project (Interagency Agreement #DASPS-3349-19). I thank Bill Burns, DOGAMI, for support and encouragement to pursue developing building footprint data; Deb Schueller, DOGAMI, for assistance in publication; and especially the members of the GEO-FIT Building Footprints Workgroup who guided me through this project.

10.0 REFERENCES

Microsoft Corporation, 2018, Microsoft Building Footprints – Features, GIS layer data.

Oregon Geospatial Enterprise Office (GEO), 2017, 2017 OSIP imagery: Salem, Oreg., Oregon Statewide Imagery Program, https://www.oregon.gov/geo/Pages/imagery_status.aspx

Oregon Geospatial Enterprise Office (GEO), 2018, 2018 OSIP imagery: Salem, Oreg., Oregon Statewide Imagery Program, https://www.oregon.gov/geo/Pages/imagery_status.aspx

11.0 APPENDIX A: EXAMPLES OF PHOTO INTERPRETATION

The examples below show structures as they appear on the reviewing imagery (GEO 2017; GEO 2018). Building versus nonbuilding structures are distinguished through photo interpretation.

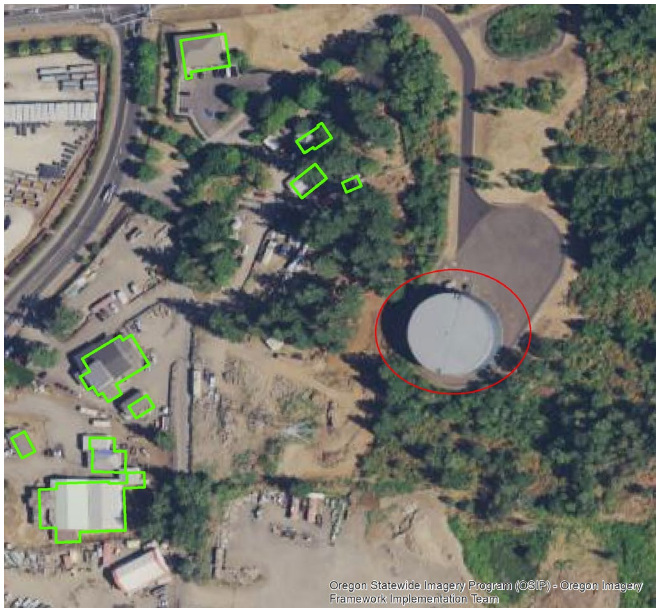
Example 1: typical residential buildings

Example 2: large machinery excluded from SBFO

Example 3: truck trailers can appear very similar to buildings

Example 4: hoop-houses are excluded from SBFO

Example 5: water tanks are excluded from SBFO



Example 6: House trailers and RVs are hard to distinguish. Also shown is a dilapidated building that was included in the SBFO.

12.0 APPENDIX B: STATEWIDE BUILDING FOOTPRINTS FOR OREGON ATTRIBUTES

We populated attributes for the SBFO using a variety of data sources where available. The following is a list of attributes and their sources.

- **ORBLD_ID** – A code that is unique for every feature in the SBFO. A hyphen joins the two parts of the code. The first part is a two-digit number indicating the county location for the building. The county number is based on the alphabetical order of the county name. The second part of the code is a seven-digit number generated by adding 100000 to the auto-generated OBJECTID value.
- **COUNTY** – The name of the county that the building footprint centroid falls within.
- **CONTRIBUTOR** – The name of the agency or organization that provided or created the building footprint data compiled into the SBFO. Many of the data contributors act as data curators and are not necessarily responsible for the building footprint digitization within the dataset contributed to the SBFO.
- **SOURCE** – Name or identifier of the imagery, lidar, CAD drawing, etc. used to generate building footprints. This information was obtained from the datasets provided from the building footprints data contributor where available.
- **SOURCE_TYPE** – The type of spatial data of the source information. This information was obtained from the datasets provided from the building footprints data contributor where available.
- **SOURCE_DATE** – The date that the source data was created. This information was obtained from the datasets provided from the building footprints data contributor where available.
- **LAG** – Lowest adjacent grade. This is derived from the statewide lidar data, digital surface model, found at DOGAMI's lidar viewer application (https://www.oregongeology.org/lidar/), and is the lowest above sea level pixel that occurs with a building footprint. This attribute is used by floodplain administrators in reference the National Flood Insurance Program. The lidar coverage in the state is not complete, so unattributed LAG records are present in the SBFO.
- **ROOF_MEAN** – Mean height of the roof. This is derived from the statewide lidar data, canopy height model, found at DOGAMI's lidar viewer application (https://www.oregongeology.org/lidar/). The mean height is calculated by averaging all the pixels that occur with a building footprint. The lidar coverage in the state is not complete, so unattributed ROOF_MEAN records are present in the SBFO.
- **ROOF_MAX** – Maximum height of the roof. This is derived from the statewide lidar data, canopy height model, found at DOGAMI's lidar viewer application (https://www.oregongeology.org/lidar/). The maximum height is calculated by identifying the highest pixel value that occurs with a building footprint. The lidar coverage in the state is not complete, so unattributed ROOF_MAX records are present in the SBFO.
- **YEAR_BUILT** – The year that the primary structure in a taxlot was built. This attribute value is applied to all buildings within the taxlot. Not all taxlots contained this attribute. -9999 indicates the attribute was not available.
- **SQ_FT** – The building footprint area in feet derived from the spatial data. The attribute is an estimation and varies widely in accuracy. Assessor data contain square footage values that are far more accurate in describing true living space.
- **REVIEW_IMG** – The name of the imagery used to verify the building footprint accuracy and perform edits if necessary.
- **REVIEW_IMG_YEAR** – Vintage of the imagery used to accomplish the most recent visual inspection. This information may not be available for maintained datasets that were not fully reviewed through the course of this project. -9999 indicates the attribute was not available.
- **REVIEW_DATE** – The date the most recent visual inspection occurred.

13.0 APPENDIX C: CONTRIBUTING BUILDING FOOTPRINT DATA ASSESSMENT

Table 13-1. Contributing building footprint datasets *(continued on next page)*. **GEO-FIT added building footprints are new data based on review of Oregon Statewide Imagery Program 2017 and 2018 high-resolution aerial imagery (GEO, 2017, 2018).**

County Name	Building Footprint Data Contributor	Original Building Footprint Count	Removed Building Footprints	GEO-FIT Added Building Footprints	SBFO Building Footprint Count
Baker	Microsoft OS	15,910	974	1,109	16,045
Benton	County GIS	54,732	16,203	1,658	41,161
	Microsoft OS	1,457	483		
Clackamas	Metro	204,215	3,300	0	200,915
Clatsop	DOGAMI	23,719	1,083	1,770	28,991
	Microsoft OS	23,877	19,292		
Columbia	County GIS	28,925	197	0	36,890
	DOGAMI	8,162	0		
Coos	DOGAMI	45,047	8,987	2,743	45,642
	Microsoft OS	39,579	32,740		
Crook	Microsoft OS	17,542	1,426	3,195	19,311
Curry	DOGAMI	19,167	1,994	1,682	19,697
	Microsoft OS	15,675	14,833		
Deschutes	Microsoft OS	97,118	3,418	14,429	108,129
Douglas	DOGAMI	4,330	268	5,694	73,229
	Microsoft OS	66,751	3,278		
Gilliam	Microsoft OS	2,955	460	150	2,645
Grant	Microsoft OS	8,173	520	1,250	8,903
Harney	DOGAMI	4,777	109	1,000	8,253
	Microsoft OS	7,736	5,151		
Hood River	DOGAMI	13,611	553	899	14,807
	Microsoft OS	12,311	11,461		
Jackson	County GIS	176,188	14,020	153	162,321
Jefferson	Microsoft OS	15,850	1,533	2,208	16,525
Josephine	Microsoft OS	57,057	272	0	56,785
Klamath	Microsoft OS	46,607	2,037	3,363	47,933
Lake	Microsoft OS	9,221	1,095	2,006	10,132
Lane	LCOG	167,205	4,771	3,361	196,108
	Microsoft OS	33,696	3,383		
Lincoln	DOGAMI	34,336	1,187	1,808	38,312
	Microsoft OS	32,740	29,385		
Linn	County GIS	93,823	372	0	93,451
Malheur	Microsoft OS	20,236	2,197	2,828	20,867
Marion	City of Salem	108,137	10,747	3,794	158,665
	Microsoft OS	60,919	3,438		
Morrow	Microsoft OS	9,078	1,306	596	8,368
Multnomah	Metro	300,270	2,026	0	298,244

County Name	Building Footprint Data Contributor	Original Building Footprint Count	Removed Building Footprints	GEO-FIT Added Building Footprints	SBFO Building Footprint Count
Polk	City of Salem	11,550	1,062	2,581	42,220
	DOGAMI	40,043	15,568		
	Microsoft OS	8,450	3,774		
Sherman	DOGAMI	2,578	847	55	2,695
	Microsoft OS	2,764	1,855		
Tillamook	DOGAMI	26,805	1,581	1,370	27,216
	Microsoft OS	22,424	21,802		
Umatilla	Microsoft OS	41,388	2,457	2,807	41,738
Union	Microsoft OS	18,009	769	2,895	20,135
Wallowa	Microsoft OS	8,578	672	1,797	9,703
Wasco	DOGAMI	16,358	213	408	19,268
	Microsoft OS	17,752	15,037		
Washington	Metro	232,692	10,303	0	222,389
Wheeler	Microsoft OS	2,504	256	465	2,713
Yamhill	DOGAMI	5,728	425	3,350	50,929
	Microsoft OS	48,743	6,467		
Total Oregon	**SBFO release 1.0**	**2,387,498**	**287,587**	**71,424**	**2,171,335**