MAK TECHNOLOGIES

# VR-TheWorld Users Guide


Version 4.15.1

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# Preface

This manual is written for persons who will use or administer VR-TheWorld.

Please see the release documentation for updates to this manual and the latest information about your version of VR-TheWorld.

# How This Manual is Organized

The chapters are organized as follows:

"Chapter 1. Introduction" on page 13 introduces you to VR-TheWorld.

"Chapter 2. Installing VR-TheWorld" on page 17 explains how to install and set up the VR-TheWorld hardware.

"Chapter 3. Configuring VR-TheWorld" on page 39 explains how to configure server and network settings. It also describes how to back up the server.

"Chapter 4. Working with Layers" on page 49 describes the different types of layers and how to create them.

"Chapter 5. Managing Files" on page 63 explains how to upload and manage the files that make up a layer.

"Chapter 6. Performance Considerations" on page 69 explains how you can improve the performance of VR-TheWorld.

"Appendix A. Terrain Sources" on page 75 lists the sources for the data in the layers shipped with VR-TheWorld.

## Documentation Set

Documentation for VR-TheWorld is provided in PDF format, as follows:

- *VR-TheWorld Users Guide*. Complete instructions for installing and administering VR-TheWorld. You can open this manual by clicking the Documentation link on the VR-TheWorld status bar.
- *VR-TheWorld First Experience*. An introduction to how to use VR-TheWorld in your visualization application.
- *VR-TheWorld Quick Start Guide*. Installation instructions.
- *VR-TheWorld Release Notes*. Last minute and release-specific information.

## MAK Products

The MAK Technologies product line includes:

- VR-Link® Network Toolkit. VR-Link is an object-oriented library of C++ functions and definitions that implement the High Level Architecture (HLA) and the Distributed Interactive Simulation (DIS) protocol. VR-Link has built-in support for the NETN FOM and RPR FOM and allows you to map to other FOMs. This library minimizes the time and effort required to build and maintain new HLA or DIS-compliant applications, and to integrate such compliance into existing applications.

  VR-Link includes a set of sample debugging applications and their source code. The source code serves as an example of how to use the VR-Link Toolkit to write applications. The executables provide valuable debugging services such as generating a predictable stream of HLA or DIS messages, and displaying the contents of messages transmitted on the network.

- MAK RTI. An RTI (Run-Time Infrastructure) is required to run applications using the High Level Architecture (HLA). The MAK RTI is optimized for high performance. It has an API, RTIspy®, that allows you to extend the RTI using plug-in modules. It also has a graphical user interface (the RTI Assistant) that helps users with configuration tasks and managing federates and federations.

- VR-Forces®. VR-Forces is a computer generated forces application and toolkit. It provides an application with a GUI, that gives you 2D and 3D views of a simulated environment.

  You can create and view entities, aggregate them into hierarchical units, assign tasks, set state parameters, and create plans that have tasks, set statements, and conditional statements. You can simulate using entity-level modeling, which focuses on the actions of individual people and vehicles, and aggregate-level modeling, which focuses on the interaction of large hierarchical units.

  VR-Forces also functions as a plan view display for viewing remote simulation objects taking part in an exercise. Using the toolkit, you can extend the VR-Forces application or create your own application for use with another user interface.

- VR-Vantage™. VR-Vantage is a line of products designed to meet your simulation visualization needs. It includes VR-Vantage and the VR-Vantage Toolkit.
  - VR-Vantage displays a realistic, 3D view of your virtual world, a 2D plan view, and an exaggerated reality (XR) view. Together these views provide both situational awareness and the big picture of the simulated world. You can move your viewpoint to any location in the 3D world and can attach it to simulation objects so that it moves as they do.
  - SensorFX. SensorFX is an enhanced version of VR-Vantage that uses physics-based sensors to view terrain and simulation object models that have been materially classified. It is built in partnership with JRM Technologies.
  - The VR-Vantage Toolkit is a 3D visual application development toolkit. Use it to customize or extend MAK's VR-Vantage applications, or to integrate VR-

Vantage capabilities into your custom applications. VR-Vantage is built on top of OpenSceneGraph (OSG). The toolkit includes the OSG version used to build VR-Vantage.

- MAK Data Logger. The Data Logger, also called the Logger, can record HLA and DIS exercises and play them back for after-action review. You can play a recorded file at speeds above or below normal and can quickly jump to areas of interest. The Logger has a GUI and a text interface. The Logger API allows you to extend the Logger using plug-in modules or embed the Logger into your own application. The Logger editing features let you merge, trim, and offset Logger recordings.
- VR-Exchange™. VR-Exchange allows simulations that use incompatible communications protocols to interoperate. For example, within the HLA world, using VR-Exchange, federations using the HLA RPR FOM 1.0 can interoperate with simulations using RPR FOM 2.0, or federations using different RTIs can interoperate. VR-Exchange supports HLA, TENA, and DIS translation.
- VR-TheWorld™. VR-TheWorld is a simple, yet powerful, web-based streaming terrain server, developed in conjunction with Pelican Mapping. Delivered with a global base map, you can also easily populate it with your own custom source data through a web-based interface. The server can be deployed on private, classified networks to provide streaming terrain data to a variety of simulation and visualization applications behind your firewall.
- DI-Guy™. DI-Guy is an SDK that allows you to embed the DI-Guy library in your real-time application and populate your world with lifelike human characters. DI-Guy provides high-fidelity human characters that move realistically, respond to simple high-level commands, and travel throughout the environment as directed by the hosting visual application. It comes with thousands of ready-to-use characters, appearances, and motions. DI-Guy character simulation is an integral part of all MAK's visual applications, including VR-Engage, VR-Forces, and VR-Vantage.
- RFView® for MAK ONE. Synthetic Aperture Radar (SAR) imaging is an indispensable tool for today's modern militaries. Developed in partnership with ISL, RFView for MAK ONE acts as a SAR server and delivers simulated SAR images that are both physically accurate and fully correlated with out-the-window views and EO/IR images of MAK ONE synthetic environments. It includes a toolkit that enables you to build a client application to request SAR images from the server.
- VR-Engage. VR-Engage is a multi-role virtual simulator that lets users play the role of a first person human character, a ground vehicle driver, gunner or commander, a sensor operator, or the pilot of a fixed wing aircraft or helicopter. It incorporates the VR-Force simulation engine and the VR-Vantage graphics rendering capabilities.
- WebLVC Server. WebLVC Server implements the server side of the WebLVC protocol so that web-based simulation federates can participate in a distributed simulation. It is part of the WebLVC Suite, which includes the server and several sample applications that work with VR-Forces and VR-Vantage.
- MAK Legion. MAK Legion is a collection of applications and an SDK designed to support simulations with millions of simulation objects.

# How to Contact Us

For VR-TheWorld technical support, information about upgrades, and information about other MAK products, you can contact us in the following ways:

## Telephone

| | | |
|---|---|---|
| Call or fax us at: | Voice: | 617-876-8085 |
| | Fax: | 617-876-9208 |

## E-mail

| | |
|---|---|
| Sales and upgrade information: | info@mak.com |
| Technical support: | support@mak.com |

## Internet

| | |
|---|---|
| MAK website home page: | www.mak.com |
| License key requests: | https://www.mak.com/mak-one/support/portal |
| Technical support: | https://www.mak.com/mak-one/support/portal |
| Product version and platform information: | https://www.mak.com/mak-one-specs |
| For the free, unlicensed MAK RTI: | https://www.mak.com/mak-one/support/help/bonus-material |

## Post

| | |
|---|---|
| Send postal correspondence to: | MAK Technologies<br>10 Fawcett Street, Suite 204<br>Cambridge, MA 02138 USA |

When requesting support, tell us the product you are using, the version, and the platform on which you are running. If you are using VR-Vantage, VR-Forces, VR-Engage, or DI-Guy, please also include your data compatibility version and date.

# Document Conventions

This manual uses these typographic conventions:

| | |
|---|---|
| **Sans Serif Bold** | Indicates a key on the keyboard or menu options. Mentions of letter keys do not require you to press the **Shift** key. If Shift is necessary, that will be included, for example, **Shift+Q**.<br>Also indicates parameters. |
| `Monospaced` | Indicates values you enter such as commands or arguments. |
| *`Monospaced Italic`* | Indicates command variables that you replace with appropriate values. |
| **{ }** | Indicates required arguments. |
| **[ ]** | Indicates optional arguments. |
| **\|** | Separates options in a command where only one option may be chosen at a time. |

| | |
|---|---|
| `( | )` | In command syntax, indicates equivalent alternatives for a command-line option, for example, `(--help | -h)`. |
| / | Indicates a directory. Since MAK products run on both Linux and Windows PC platforms, we use the / (slash) for generic discussions of pathnames. |
| *Italic* | Indicates a file name, pathname, or a class name. |
| ➤ | Indicates a procedure. |
| **Menu > Option** | Indicates a menu choice. For example, an instruction to select the Save option from the File menu appears as:<br>Choose **File > Save**. |
| ⓘ | Indicates supplemental or clarifying information. |
| ⚠ | Indicates additional information that you must observe to ensure the success of a procedure or other task. |

Directory names are preceded with dot and slash characters that show their position with respect to the VR-TheWorld home directory. For example, the directory *./vrlink4.15.1/doc* appears in the text as *./doc*.

### Mouse Button Naming Conventions

An instruction to click the mouse button refers to clicking the primary mouse button, usually the left button for right-handed mice and the right button for left-handed mice. The context-sensitive menu, also called a popup menu or right-click menu, refers to the menu displayed when you click the secondary mouse button, usually the right button on right-handed mice and the left button on left-handed mice.

## Third-Party Licenses

MAK software products may use code from third parties. For an up-to-date list of supported third-party and open source libraries and the associated license information, please visit the MAK ONE Product Support Knowledge Base (at https://www.mak.com/knowledge) and refer to the Third-Party/Open Source List under Frequently Asked Questions (FAQ).

### ECW Server License

To support the ERDAS Enhanced Compressed Wavelet (ECW) raster files on VR-TheWorld, you must purchase an ERDAS ECW/JP2 Server Read-Only End-user SDK License from Hexagon Geospatial. You can request a quote from their Pricing Request Page (https://go.hexagongeospatial.com/pricing-request).

ECW support is built into VR-TheWorld. Once you purchase a license, contact MAK Support to receive instructions on enabling it.

JPEG2000 (.jp2) support is separately licensed and already included, so this license is needed only if you want to directly add ECW files into Raster layers on VR-TheWorld. Alternatively, without the license, you can use non-server based tools (GDAL, QGIS, Esri ArcMap) to convert ECW files into other formats that can be directly supported (for example, Geotiff, JPEG200, or MrSID).

The MAK COTS products also already support local loading of local ECW files, therefore no additional license is required other than for direct support on VR-TheWorld.

# 1. Introduction

VR-TheWorld is MAK's streaming terrain server.

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# 1.1. Introduction to VR-TheWorld

VR-TheWorld is a simple—and powerful—web-based streaming terrain server, developed in conjunction with MAK's technology partner, Pelican Mapping. It is delivered with a global base map. However, you can also easily populate it with your own custom source data through a web-based interface. You can deploy the server on private, classified networks to provide streaming terrain data to a variety of simulation and visualization applications behind your firewall.

VR-TheWorld has over 4 terabytes of global elevation, imagery, and feature data, which are pre-tiled for high performance access. The VR-TheWorld Basemap has:

- Global elevation. 30 m (comparable to DTED Level 2) for the entire globe.
- Global imagery. Sentinel-2 (10 m resolution) cloudless dataset, developed by EOX IT Services GmbH. The dataset modified Copernicus Sentinel data 2020. Available for LOD 0–13. For more details about the EOX Viewing Ready product, visit the EOX IT Services GmbH website (https://eox.at).
- High-resolution inset areas. The insets range from 1 m to 15 cm per pixel – including southern California, Boston, Guam, Switzerland, Washington, D.C., and two airport areas in Afghanistan.
- Maxar Precision 3D samples. 0.5 m imagery and land cover for Schwyz, Switzerland. 0.5 m 3DTiles Digital Surface Model (DSM) for Jalalabad, Afghanistan. https://www.maxar.com/products/precision3d-data-suite.
- Samples of 1:250,000 and 1:100,000 topographic maps in Southern California.
- Highly detailed California map with 2 ft or better imagery.
- Landcover: Global Copernicus 30 m 2019 plus insets for US, Europe, California, Hawaii, and Guam.
- OpenStreetMap in MBTiles format.
- A highly detailed map of Hawaii, which includes:
  - 15 m Harris Terracolor imagery, added to make the area surrounding the Hawaiian Islands look more like deep blue water. This product has a very nice view of the shallow water boundaries between the ocean and the islands.
  - 1 ft USGS Mosaicked Digital Orthophoto Quadrangles (MDOQs) produced through the National Digital Orthophoto Program (NDOP) for the island of Oahu.
  - 1 ft water replacement imagery custom built by Harris, includes Digital Globe WV2 Imagery blended into Oahu Imagery and Harris Terracolor Imagery to ease the transition between the 15 m and 1 ft imagery.
  - 10 m Digital Elevation Model from USGS.
  - Feature data for Oahu, including building footprints for 200,000 buildings.

VR-TheWorld uses open standards such as WMS-C (Web Mapping Service-Cached, from Open Geospatial Consortium) and WFS (Web Feature Service, from the Open Geospatial

Consortium). This means that clients are not limited to MAK's visualization or simulation tools. Any customer or third-party application that supports WMS-C (including web applications) can access VR-TheWorld immediately.

# 2. Installing VR-TheWorld

This chapter explains how to install the VR-TheWorld.


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## 2.1. Installing VR-TheWorld Software and Data

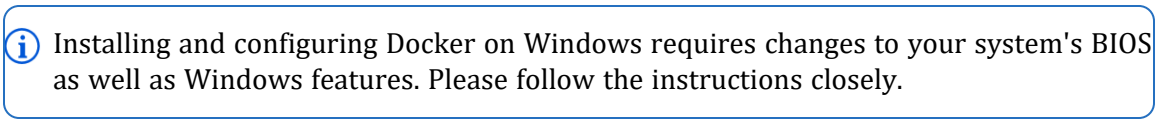
VR-TheWorld is built on the Docker platform. This allows you to use Linux or Windows as platforms to run VR-TheWorld.

A VR-TheWorld installation has the following software and hardware components:

- Docker. A web-based application used to deliver the VR-TheWorld database structure and data.
- VR-TheWorld software.
- VR-TheWorld database structure and data files. The database provided by MAK is optional. You can create your own database and use your own data files. You can also add your data files to those provided by MAK.
- Hard drive. MAK provides a hard drive with installation scripts and data files.

The minimum recommended hardware configuration for running VR-TheWorld is:

- Server:
  - Multi-core
  - 32 GB RAM
  - 250 GB hard drive
- Data storage:
  - 5 TB or more of usable space (after configuration).
- Operating system. Preferably the latest versions of Ubuntu, Windows, or Red Hat Enterprise Linux (RHEL), but at a minimum:
  - Ubuntu 24.04
  - Windows 10
  - RHEL 8




### 2.1.1 Considerations for Using Docker

This section discusses the following issues that you may need to consider when using Docker:

- Ports
- Handling crashes and reboots
- Path syntax

### Ports

Docker does not bypass firewalls. It creates rules inside the kernel to redirect traffic that comes to the host. The *docker-compose* file lists the used ports in the following format:

```
host_port : docker_port
```

By default, Docker exposes container ports to the IP address 0.0.0.0. (This matches any IP on the system). If you want to, you can tell Docker which IP address to bind on. For example, to bind on localhost port 3000 and container port 80, specify:

```
127.0.0.1:3000:80
```

Some customers may prefer this for security reasons. Otherwise, that host port becomes open to all incoming connections.

### Handling Crashes and Reboots

You can implement a restart policy for your Docker container that prevents the need to manually restart the containers in the case of a crash or reboot.

You do this through the `--restart` argument, which can be called within the docker `run` command or the docker `update` command (once containers are running). For our case, the docker `update` command makes more sense because the docker `run` command is not called explicitly during the installation process.

Here is how to set this for a single container:

```
docker update --restart unless-stopped container_name
```

Here is how to set this for all containers:

```
docker update --restart unless-stopped $(docker ps -q)
```

Table 1 lists the potential values for the `--restart` flag. `unless-stopped` is the most commonly used value. It is designed for the use case of handling a server crash / reboot.

**Table 1. Values for --restart flag**

| Command | Description |
|---|---|
| no | Default value - containers would not be restarted. |
| on failure | Restarts container in the case of an error (container crashes). |
| always | Always restart container if it stops. |
| unless-stopped | Always restart container unless it is manually stopped. |

### Specifying Paths in Docker

Declare all paths using a forward slash (/), not the Windows-standard backslash (\). Items are appended to Docker paths following a Unix format, therefore a path that mixes backslashes with forward slashes becomes invalid. If you want to declare the paths in a Windows format, set the COMPOSE_CONVERT_WINDOWS_PATHS environment variable to 1.

# 2.2. Installing VR-TheWorld on Linux

This section explains how to install VR-TheWorld on Linux operating systems.

Docker is supported for versions of Linux including Ubuntu. For RHEL 8 or later, use Podman.

## 2.2.1 Setting Up Your Computer

Variations in Linux systems may create problems installing Docker and running VR-TheWorld. Please review the issues discussed in this section to ensure that your system is properly set up.

### Partition Setup

It is recommended that you configure */etc/fstab* to point to drives by UUID. If drives are not configured by UUID, the mount locations or order of the drivers might change after you restart the server.

Partitions should use the XFS scheme. Non-XFS partitions may experience problems when copying the contents of the external drive to the internal drive.

## 2.2.2 Installing Docker

Download and install Docker. Follow the instructions at https://docs.docker.com/engine/install. You also must install Docker Compose, which is a separate installation if you are using Docker Engine but is included if you install Docker Desktop.

> For RHEL 8 or later, although Docker is avaiable, Podman is the native container runtime environment included with RHEL. It is recommended that you use Podman to provide comparable functionality to the Docker environment. See "2.2.3 Using Podman Instead of Docker for RHEL 8 and Later" on the facing page.

### Using docker-compose or docker compose

Docker Compose is a tool for defining and running multi-container applications. It stops and starts the server. Compose has had several versions over the years. The original format for invoking the commands was `docker-compose`. Newer versions, however, use `docker compose`, although `docker-compose` should also be aliased. The documentation still uses `docker-compose`.

### Configure the Firewall

Firewall settings may restrict the usage of certain ports through docker.

➤ **To set up the firewall:**

1. Find out which zone the docker interface it bound to, most likely "no zone":

   ```
   sudo firewall-cmd --get-zone-of-interface=docker0
   ```

2. Add the docker0 interface to the public zone. Changes will be visible only after firewalld reloads:

   ```
   sudo nmcli connection modify docker0 connection.zone public
   ```

3. Add masquerading, which allows for docker ingress and egress:

   ```
   sudo firewall-cmd --zone=public --add-masquerade --permanent
   ```

4. Reload firewalld:

   ```
   sudo firewall-cmd --reload
   ```

5. Reload dockerd:

   ```
   sudo systemctl restart docker
   ```

## 2.2.3 Using Podman Instead of Docker for RHEL 8 and Later

For RHEL 8 or later, Podman is the native container runtime environment and includes the Red Hat tools *buildah*, *podman*, and *podman-compose*. Although you could manually download and install Docker, it is best to use the native tools.

Like Docker, Podman is a tool designed to make it easy to find, run, build, share, and deploy applications using Containers and Container Images. Podman provides a command line interface (CLI) familiar to anyone who has used the Docker Container Engine. Most users can simply alias Docker to Podman (alias docker=podman) without any problems, or you can use the corresponding podman commands (for example, podman-compose).

For VR-TheWorld, Podman uses the same Docker container and the provided docker-compose.yml.

To install podman and podman-compose on Red Hat, you can either download and install the Podman Desktop for Linux from https://podman-desktop.io or run the following commands:

- `sudo yum -y install podman`
- `sudo yum –y install python3-pip`
- `sudo pip3 install podman-compose`

Continue with the rest of the Linux installation instructions. If you have not aliased docker to podman, use the corresponding podman command (for example, podman-compose instead of docker-compose).

> ⓘ The firewall may also restrict the usage of certain ports through Podman. See "Configure the Firewall" above.

### 2.2.4 Creating a New Network

Use either Docker or Podman to create a new network and give it the name `vrtheworld_default`.

### 2.2.5 Installing the Data Drive

You must mount the data drive and create the installation directory. The drive is in XFS format.

➤ **To mount the data drive:**

1. The data drive has a USB connection. Attach it to a USB 3.0 port on your computer.
2. Issue the following command to get the location of the drive:

   ```
   sudo fdisk -l
   ```

   This lists all drives connected to the computer. The MAK data drive is called */dev/sd**, where * is a letter from a–z. The data drive size is 6000 GB. Write down the name of the MAK drive.
3. Create the data directory:

   ```
   sudo mkdir -p /data
   ```

> ⚠ If your machine already has a */data* directory or you want to install the VR-TheWorld software, source data, and tiles into another location (for example, a different large partition), use a different directory. If you do install to a directory other than */data*, be sure to use that directory name instead of */data* in the following installation steps. You must also edit the *docker-compose.yml* file that you created and map all the volumes from the installed location to the internal */data* used within the Docker images.

### 2.2.6 Copy Data or Mount the Data Drive

You can run VR-TheWorld from the data drive or copy the data to your computer's hard drive. For best performance, MAK recommends that you copy the data to your computer's hard drive.

➤ To copy the contents of the MAK data drive to an internal drive, run the following command:

```
xfsdump -J - /dev/NAMEOFDRIVE | xfsrestore -J - /data
```

where *NAMEOFDRIVE* is the name you recorded when you got the location of the disk.

> ⓘ
> - Copying the data can take more than 8–10 hours. Do not interrupt the process.
> - Partitions should use the XFS scheme. Non-XFS partitions may experience problems when copying the contents of the external drive to the internal drive.

> ⚠ When installing a new version of VR-TheWorld and the MAK data over an older version of VR-TheWorld, be aware that the xfsrestore will merge with the existing data, replacing duplicate files but leaving any different files intact. This can result in retaining MAK data that is no longer used, but it also preserves any customer data that you have added.

➤ If you choose to run VR-TheWorld from the data drive, rather than copying data, mount the data drive to */data*:

```
sudo mount /dev/NAMEOFDRIVE /data
```

where *NAMEOFDRIVE* is the name you recorded when you got the location of the disk.

## 2.2.7 Installing VR-TheWorld

VR-TheWorld organizes data into layers, which reference the data files. You must install the database structure. You can do so automatically or manually.

VR-TheWorld requires a post-installation license key. Request a license at https://www.mak.com/mak-one/support/portal. Include your contact information, the purchase order for the server, and any relevant program details. You use the license key in step 4.

➤ **To install VR-TheWorld:**

1. After you receive your license key from MAK support, change directory to the install directory:

   ```
   cd /data/VRTheWorld
   ```

2. Ensure that the prefix is set to 24. (RHEL 8.x defaults to 8.) If it is, continue to step 3.

   If it is not:

   a. Run:

      ```
      sudo vi /etc/sysconfig/network-scripts/ifcfg-<eno1>
      ```

      where *<eno1>* is the name of your ethernet port.

   b. After changing the name of the ethernet port, run:

      ```
      sudo nmcli connection down eno1
      sudo nmcli connection up eno1
      ```

3. Copy the default Linux setting file, *docker-compose-linux.yml*, to *docker-compose.yml*.
4. Edit that *docker-compose.yml* file. At the end of it, there is a line `LICENSE_TEXT=`. Copy the license key text that you received and then paste it to the end of that line. Save the file.
5. Optionally, when you edit *docker-compose.yml*, you can configure the options. The file includes comments that explain the options. For more information, see "Configuration Options for Docker" on the next page.

6. Load the images for VR-TheWorld (you must have elevated permissions to run these commands):

```
docker load < postgis_16-3.5-alpine.tar.gz
docker load < redis_5.0-alpine.tar.gz
docker load < maptilergl_5.5.0.tar.gz
docker load < dozzle_10.0.4.tar.gz
docker load < vrtheworld_VERSIONOFVRTW.tar.gz
```

   where *VERSIONOFVRTW* is the version of VR-TheWorld you are installing.

   > If you have RHEL 8 or later and are using Podman, use the `podman` command line instead if you have not aliased docker. For example:
   >
   > ```
   > podman load < postgis_16-3.5-alpine.tar.gz
   > ```

7. Start VR-TheWorld:

```
docker-compose up -d
```

At this point, you can access VR-TheWorld using a web browser. Enter the URL, http://*host*/vr-theworld, where *host* can be either: the IP address of the server, localhost (or 127.0.0.1) if you are running on the server, or the hostname of the server PC. The default username and password are `readymap`. Note that the server contains no predefined layers.

### Configuration Options for Docker

In the *docker-compose.yml* file, you can pass optional arguments to our docker container to increase your VR-TheWorld performance. These are defined in the optional environment section of the file. Table 2 describes the environment variables.

**Table 2. Docker environment variables**

| Variable | Description |
|---|---|
| NUM_WORKERS | The number of background workers started for processing general background tasks. |
| NUM_TILERS | The number of background workers started for seeding map tiles via cache jobs. |
| NUM_TILE_ GENERATORS | The number of background workers started for generating map tiles on demand. |
| GENERATE_ TILES_IN_ BACKGROUND_ WORKER | Whether to generate tiles on demand in a background process or in the main Apache process. By default, tiles are generated in a background process to avoid bogging down the server during periods of high load. Set this environment variable to False to restore the original behavior of generating tiles in the main Apache process. |
| USE_LAYER_ NAMES | When set to True, VR-TheWorld will expose layers using their name instead of their ID in GIS services. This could make switching between VR-TheWorld servers that have similar layer names easier when configuring earth files. |

As a general guideline, you should match NUM_TILE_GENERATORS and NUM_GENERATE_ON_DEMAND_PROCESSES to how you plan to use the server and the number of cores on the system. For example, increasing NUM_TILE_GENERATORS helps if you plan to add and tile new data and layers. Increasing NUM_GENERATE_ON_DEMAND_PROCESSES helps during server runtime if some layers are not fully tiled and have enabled the **Generate tiles on demand** option. The specific number for each should map to the number of cores on your system, and therefore should be different for 8 versus 16 versus 32 cores. Remember to reserve cores for other processes and the server web services.

To set environment variables in *docker-compose.yml*, read the instructions at: https://docs.docker.com/compose/compose-file/#environment.

### 2.2.8 Installing the MAK-Supplied Database

VR-TheWorld does not presume any particular data. You can load your own database or the database supplied by MAK. If you are using MAK ONE applications such as VR-Vantage or VR-Forces, the terrain database files provided with these applications presume use of the MAK database structure and data files.

This section explains how to load the MAK database.

> ⚠ If you load the MAK database using `readymap_restore`, it removes all of the other previously defined layers from the server. Be sure to back up your existing database if you have made any changes, for example:
>
> `docker-compose exec readymap readymap_backup /data/backups/vrtw-myDB.db` (Windows)

➤ **To install the MAK database:**

1. Change directory to the VR-TheWorld install directory:

   ```
   cd /data/VRTheWorld
   ```

2. Shut down the docker containers and restart them:

   ```
   docker-compose down
   docker-compose up -d
   ```

3. Load the database into readymap:

   ```
   docker-compose exec readymap readymap_restore
   /data/backups/vrtw4.db
   ```

> ⓘ This command uses */data/backups/vrtw4.db* because this in the path defined in the Docker container. On the hard drive, the file exists in the default mount location, */data/added/backups*, but the Docker VOLUME is configured in the docker.yml file.

Starting with the March 2024 MAK database, there is a significant change to the data layers provided with VR-TheWorld. VR-TheWorld now supports WebP format raster imagery layers. WebP combines the best of the JPEG and PNG formats, providing lossy or lossless compression and supporting transparency. WebP also produces images that are smaller than both corresponding PNG or JPEG images. The database introduces a new global imagery layer, based on Sentinel-2, which is a WebP layer. Depending on which

versions of the MAK ONE products that you need to support, you may want to manage tiling of the global imagery layers to either conserve disk space or pre-tile areas for better performance. See "2.7. Managing VR-TheWorld Global Imagery Layers" on page 36 for more details.

### 2.2.9 Configuring VR-TheWorld Server to Autostart on Boot

You can set VR-TheWorld Server to start automatically when you boot the system without requiring a user to log in and run `docker-compose`.

➤ **To set the Docker or Podman machine to autostart:**

1. Stop the VR-TheWorld Server if it is running:

   ```
   cd /data/VRTheWorld
   docker-compose down
   ```

2. Create a new file, *vrtheworld.service*, in the */etc/systemd/system/* directory.

3. Edit *vrtheworld.service* and add:

   ```
   [Unit]
   Description=Start VR-TheWorld Server
   After=network.target

   [Service]
   Type=oneshot
   WorkingDirectory=/data/VRTheWorld
   ExecStart=/bin/docker-compose up -d
   ExecStop=/bin/docker-compose down
   RemainAfterExit=yes

   [Install]
   WantedBy=multi-user.target
   ```

   where *WorkingDirectory* is the directory where your *docker-compose.yml* file is located. If you use Podman and you have not installed or aliased `docker-compose`, change to `podman-compose` (or `podman compose`).

4. After creating *vrtheworld.service*, reload the systemd manager configuration to recognize the new service:

   ```
   sudo systemctl daemon-reload
   ```

5. Next, enable the service to start at boot:

   ```
   sudo systemctl enable vrtheworld.service
   ```

6. To start the service immediately:

   ```
   sudo systemctl start vrtheworld.service
   ```

7. Test to make sure the VR-TheWorld server is accessible using a web browser.

## 2.3. Installing VR-TheWorld on Windows

This section explains how to install VR-TheWorld on Windows.

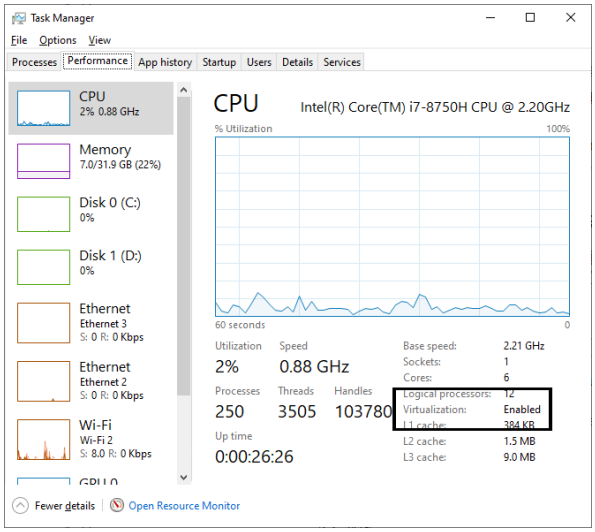
## 2.3.1 Prerequisites for Using Docker

To use Docker on Windows, you must enable virtualization, WSL2 (Windows Subsystem for Linux version 2), and Hyper-V. These are all capabilities that are built into Windows, but which might not be enabled.

➤ **To check the status of virtualization:**

1. Open Task Manager.
2. Select the Performance tab.
3. The status of virtualization displays under the graph (Figure 1).

**Figure 1. Task Manager, Performance tab**




If virtualization is not enabled, you must enable it. Instructions for doing so are readily available using an internet search.

### Windows 10

➤ **To enable Hyper-V and WSL on Windows 10:**

1. Open the Control Panel.
2. Click Programs.
3. Click Turn Windows Features On or Off. The Windows Features window opens.
4. In the list, locate Hyper-V and Windows Subsystem for Linux. Select those check boxes.
5. Click OK.
6. Restart the machine to apply your changes.

#### Windows 11

➤ **To enable Hyper-V and WSL on Windows 11:**

1. Open Settings.
2. Click Apps.
3. Click Optional Features.
4. Click Add a Feature and then locate Hyper-V. Select the check box and then click Install.
5. Click Add a Feature and then locate Windows Subsystem for Linux. Select the check box and then click Install.
6. Restart the machine to apply your changes.

#### Check for and Install Latest Version of WSL2

➤ **To check the WSL version and ensure that version 2 is enabled or either Windows 10 or 11:**

1. As an administrator, run a Command Prompt window (or PowerShell).
2. Type `wsl -v` and then press Enter.
3. When the version is returned, check that it begins with 2.
4. You should also ensure that the latest version of WSL is installed. To install it, type `wsl --update` and then press Enter.

### 2.3.2 Docker or Podman Desktop Application

For Windows, there are two supporting environments that you can use to run Docker containers: Docker Desktop or Podman Desktop.

As of 2022, Docker Desktop changed from an open-source model to a paid subscription. Commercial use of Docker Desktop at a company of more than 250 employees or more than $10 million in annual revenue requires a paid subscription. If this applies and you prefer not pay the subscription, use Podman Desktop.

#### Installing Docker Desktop

➤ **To install Docker Desktop:**

1. Download and install Docker Desktop.
2. Follow the instructions at https://docs.docker.com/desktop/install/windows-install.

#### Installing Podman Desktop

➤ **To install Podman Desktop:**

1. Download and install Podman Desktop for Windows.
2. Follow the instructions at https://podman-desktop.io/docs/installation/windows-install.
3. Once the installation is complete, be sure to set up the Compose Resources.

You can run Podman either under the root user (rootful) or a non-privileged user (rootless). When installed, rootless is the default. However, Docker containers normally function with root privileges. You can switch the machine to rootful by stopping it and using the set command.

➤ **To switch your machine to rootful:**

1. Open a Command Prompt window.
2. Enter the following commands:

```
podman machine stop
podman machine set --rootful
podman machine start
```

ⓘ If you update the components of the Podman Desktop for Windows (for example, you update to a new version in the Desktop GUI), after updating, you must repeat this step and restart the VR-TheWorld Docker container.

### 2.3.3 Attach the Data Drive and Copy Data

The drive provided by MAK for Windows is in NTFS format.

➤ **To attach the data drive and copy the data:**

1. Plug the USB cable from the data drive into a USB port on your machine.
2. Open a console window.
3. Enter `diskmgmt.msc`. The screen displays a list of all drives connected to the system.
4. Write down the letter of the data drive provided.
5. In Windows File Explorer, create a directory (folder) called `data` on the target drive. VR-TheWorld uses this directory to store all the files it needs to use.

   ⓘ If you had a previous installation of VR-TheWorld, be sure to delete all the files in your data drive. If you added your own data, do not delete that data but do delete everything else. Depending on the copy process you use, it may or may not overwrite your data.

6. Copy the data from the source directory to your data directory. The source and tile data contain millions of files, which can cause the copy process to take a very long time.

   Be sure the copy process that you use preserves symbolic links. See "2.5. Troubleshooting Installation Problems" on page 35 if you cannot access the OpenStreetMap data using your configurations files.

### 2.3.4 Configuring Podman to Autostart

If you are using Podman, you must ensure that the VR-TheWorld container automatically starts when Windows boots up.

➤ **To configure Podman to autostart on Windows boot:**

1. Run the Windows Task Scheduler as a user with Administrator privileges.
2. Create a new task by clicking **Action > Create Task**.
3. In the General tab:
    a. Enter a Name, such as `Start VR-TheWorld`.
    b. Enter a description, such as `Start the VR-TheWorld Server at login`.
    c. Select the option Run Whether User Is Logged On or Not.
    d. From the Configure For list, select the version of your OS (Windows 10 or 11).
4. Select the Triggers tab and then click New. The New Trigger dialog box opens.
5. In the New Trigger dialog box:
    a. From the Begin the Task list, select At Startup.
    b. Select the Delay Task For check box and then select 1 Minute.
    c. Select the Enabled check box.
    d. Click OK to add the new trigger and return to the Create Task dialog box.
6. Select the Actions tab and then click New. The New Action dialog box opens.
7. In the New Action dialog box:
    a. From the Action list, select Start a Program.
    b. Click the Browse button next to the Program/Script box.
    c. Locate podman.exe (for example, *C:/Program Files /RedHat/Podman/podman.exe*) and then click Open.
    d. In the Add Arguments box, enter `machine start`.
    e. Click OK to add the new action and return to the Create Task dialog box.
8. In the Actions tab, click New to add a second action.
9. In the New Action dialog box:
    a. From the Action list, select Start a Program.
    b. Click the Browse button next to the Program/Script box.
    c. Locate docker-compose (or podman-compose), select it, and then click Open.
    d. In the Add Arguments box, enter `up -d`.
    e. In the Start In box, enter the location of where you copied the VR-TheWorld directory (for example, *D:/VRTheWorld*).
    f. Click OK to add the new action.
10. In the Actions tab, make sure that both actions are listed and also that podman.exe is first in the list.
11. Select the Conditions tab and clear all of the Start check boxes.
12. Select the Settings tab and:

a. Select Run Task as Soon as Possible After a Scheduled Start Is Missed

b. Select If The Task Fails, Restart Every and then select 1 Minute.

c. In the Attempt to Restart Up To box, enter 5.

13. Click OK to add the scheduled task. When you reboot the machine, VR-TheWorld should be accessible as a service without requiring a login.

## 2.3.5 Configuring WSL2 Networking

By default, WSL uses a NAT (Network Address Translation) based architecture for networking. WSL2 has a virtualized ethernet adapter with its own unique IP address. To connect to the web service running in the Docker container, running as part of WSL2, you must complete the following steps to allow access to VR-TheWorld using the IP address of your Windows PC.

Use the `Netsh` interface command to add a port proxy that listens on your host port and connects that port proxy to the IP address for the WSL2 VM.

➤ **To configure WSL2 networking:**

1. As an administrator, run PowerShell or open a Command Prompt window.
2. Enter the following command, where *`eth0 IP address`* is the address of the ethernet adapter inside WSL2. To get this address, start a terminal for the Linux running inside WSL2 and then type ifconfig. The inet address will be displayed with eth0.

   ```
   netsh interface portproxy add v4tov4 listenport=80
   listenaddress=0.0.0.0 connectport=80 connectaddress=eth0 IP
   address
   ```

   In this command, the port numbers are both 80. The `listenaddress=0.0.0.0` means that incoming requests will be accepted from any IP address.

   You also need to do this for other ports that are used by the server, for example, ports 8080 and 8081, if using the defaults, or the specific port you choose in your docker-compose.yml.
3. You may also need to update your Windows Firewall rules to enable connections to port 80. If you are unable to because of security restrictions, you can use an alternate port, but you must then update the ports definition to <*port#*>:80 in your *docker-compose.yml* file and access the server using <*`PC nameorIP address`*>:<*`port #`*>`:/vr-theworld`.

## 2.3.6 Installing VR-TheWorld

You can pass optional arguments to our docker container to increase your VR-TheWorld performance. These are defined in the optional environment section of the file. Table 2 on page 24 describes the environment variables.

VR-TheWorld requires a post-installation license key. Request a license at https://www.mak.com/mak-one/support/portal. Include your contact information, the purchase order for the server, and any relevant program details. You use the license key in step 6.

➤ **To install VR-TheWorld on Windows:**

1. After you receive your license key from MAK support, open a console window.
2. Change directory to the data drive:

   ```
   cd DATADRIVE:\data\VRTheWorld
   ```

3. Copy *docker-compose-windows.yml* to *docker-compose.yml*.
4. In a text editor, open *docker-compose.yml*.
5. In the lines under `volumes:`, replace `DATADRIVE` with the drive letter where you installed the data.
6. At the end of the file, there is a line `LICENSE_TEXT=`. Copy the license key text that you received and then paste it to the end of that line.
7. Save the file and close it.
8. In your console window, in *DATADRIVE:/data/VRTheWorld*, execute the following commands:

   ```
   docker load -i postgis_16-3.5-alpine.tar.gz
   docker load -i redis_5.0-alpine.tar.gz
   docker load -i maptilergl_5.5.0.tar.gz
   docker load -i dozzle_10.0.4.tar.gz
   docker load -i vrtheworld_VERSIONOFVRTW.tar.gz
   ```

   where *VERSIONOFVRTW* is the version of VR-TheWorld that you are installing.

9. Start VR-TheWorld:

   ```
   docker-compose up -d
   ```

   ⓘ If you use Podman Desktop, use the podman command-line option instead, if you have not aliased docker. For example:

   ```
   podman load < postgis_16-3.5-alpine.tar.gz
   ```

You can now access VR-TheWorld using a web browser. Enter the URL, http://*host*/vr-theworld, where *host* can be either: the IP address of the server, localhost (or 127.0.0.1) if you are running on the server, or the hostname of the server PC. The default username and password are `readymap`.

## 2.3.7 Installing the MAK-Supplied Database

VR-TheWorld does not presume any particular data. You can load your own database or the database supplied by MAK. If you are using MAK ONE applications such as VR-Vantage or VR-Forces, the terrain database files provided with these applications presume use of the MAK database structure and data files.

This section explains how to load the MAK database.

> ⚠ If you load the MAK database using `readymap_restore`, it removes all of the other previously defined layers from the server. Be sure to back up your existing database if you have made any changes, for example:
>
> `docker-compose exec readymap readymap_backup /data/backups/vrtw-myDB.db` (Windows)

➤ **To install the MAK database:**

1. Change directory to the VR-TheWorld install directory:

   ```
   cd DATADRIVE:\data\VRTheWorld
   ```

2. Shut down the docker containers and restart them:

   ```
   docker-compose down
   docker-compose up -d
   ```

3. Load the MAK database into readymap (this takes 5 to 10 minutes):

   ```
   docker-compose exec readymap readymap_restore
   /data/backups/vrtw4.db
   ```

> ⓘ This command uses */data/backups/vrtw4.db* because this in the path defined in the Docker container. On the hard drive, the file exists in the default mount location, */data/added/backups*, but the Docker VOLUME is configured in the docker.yml file.

Starting with the March 2024 MAK database, there is a significant change to the data layers provided with VR-TheWorld. VR-TheWorld now supports WebP format raster imagery layers. WebP combines the best of the JPEG and PNG formats, providing lossy or lossless compression and supporting transparency. WebP also produces images that are smaller than both corresponding PNG or JPEG images. The database introduces a new global imagery layer, based on Sentinel-2, which is a WebP layer. Depending on which versions of the MAK ONE products that you need to support, you may want to manage tiling of the global imagery layers to either conserve disk space or pre-tile areas for better performance. See "2.7. Managing VR-TheWorld Global Imagery Layers" on page 36 for more details.

## 2.4. Enabling SSL for VR-TheWorld

By default, VR-TheWorld is configured to use HTTP (Hypertext Transfer Protocol). HTTP does not encrypt data, which means that any data transferred can potentially be intercepted and read by others. However, it is faster because it does not encrypt data. HTTP uses port 80 by default.

Optionally, you can configure the server to use HTTPS (Hypertext Transfer Protocol Secure), which is an extension of HTTP that uses the SSL/TLS protocol for encryption and authentication. It ensures that data sent from the server remains encrypted. HTTPS uses port 443 by default.

To enable HTTPS/SSL, you must obtain a digital certificate that authenticates a website's identity and enables an encrypted connection. The certificate contains the website's public key and other information. There are a number of commercial Certificate Authorities or tools to generate certificates.

Once you have a certificate, you must store it on the server PC. Add the certificates to the server:

- For Linux, the certificate files can be copied to */etc/ssl/certs* or you can create a directory within the VR-TheWorld directories (for example, */data/VRTheWorld/certs*).
- For Windows, create a location for the certificates, which could be in your VR-TheWorld directories (for example, *D:\data\VRTheWorld\certs*)

After the certificate is installed, you need to update your *docker-compose.yml* file:

1. Change directory (`cd`) to the *data/VRTheWorld* directory.
2. Stop you server: `docker-compose down`.
3. Edit your *docker-compose.yml* file.
4. Add the following:
   a. To volumes, for example on Linux:

      ```
      - /etc/ssl/certs:/etc/ssl/certs # Location of SSL certs on local machine outside of container
      ```

      To volumes, for example on Windows:

      ```
      - D:\data\VRTheWorld\certs:/etc/ssl/certs # Location of SSL certs on local machine outside of container
      ```

      where the first part is the location of your certificates, in Linux or Windows format.

   b. Add to ports:

      ```
      - "443:443"
      ```

   c. Add to environment:

      ```
      - USE_SSL=1
      - SSL_CERTIFICATE_FILE=/etc/ssl/certs/vrtheworld-cert.crt
      - SSL_CERTIFICATE_KEY_FILE=/etc/ssl/certs/vrtheworld-cert.key
      - SSL_CERTIFICATE_CHAIN_FILE=/etc/ssl/certs/vrtheworld-cert.crt
      ```

      where the *crt* and *key* values are the location and name of your certificates, respectively.
5. Save the file.
6. Restart the server: `docker-compose up -d`

You should now be able to access your server using

`https://<your IP address>/vr-theworld`

HTTP calls will continue to work, but they will automatically redirect to HTTPS.

## 2.5. Troubleshooting Installation Problems

The installation scripts create log files. If you have problems installing VR-TheWorld 4.15.1, please contact support at https://www.mak.com/mak-one/support/portal and include the log files with a description of the problem.

If performance of VR-TheWorld GUI map is sluggish, make sure that you have enabled hardware acceleration for WebGL. The specific setting depends on your browser and version. For example:

- Microsoft Edge. Open the Settings and then go to the System and Performance page. Make sure Use Hardware Acceleration When Available is enabled.
- Google Chrome. Open the Settings and then go to the System page. Make sure Use Hardware Acceleration When Available is enabled.

### 2.5.1 Checking OpenStreetMap Symbolic Links

VR-TheWorld includes snapshots of the OpenStreetMap (OSM) features in MBTiles format. The file names include their respective dates along with separate symbolic links with generic names, which are used in the configuration files. This allows the OSM data to be updated and the symbolic links changed without affecting the configuration files.

Some methods for copying the data drive to a local drive do not preserve symbolic links.

➤ **To verify that the links are correctly defined:**

1. Open a console terminal on your VR-TheWorld server.
2. Change directory (`cd`) to your */data/added/mbtiles* directory.
3. List all the files in the directory, showing the full contents, for example, `dir` on Windows or `ls -al` on Linux.
4. Check for the symbolic links.
   - On Windows, it will look like:

     `<SYMLINK>  osm.mbtiles [osm-qa-MM-DD-YYYY.mbtiles]`
   - On Linux, it will look like:

     `osm.mbtiles -> osm-qa-MM-DD-YYYY.mbtiles`
5. If the links do not exist, you must manually create them for each of the dated *.mbtiles* files. For example:
   - Windows:

     `mklink osm.mbtiles osm-qa-MM-DD-YYYY.mbtiles` (format is `mklink <link> <target>`)
   - Linux:

     `ln -s osm-qa-MM-DD-YYYY.mbtiles osm.mbtiles` (format is `ln -s <target> <link>`)
6. List all the files in the directory, showing the full contents again, and you should now see the symbolic links.

## 2.6. Upgrading to VR-TheWorld 4.15.1 from Versions Earlier than 4.7

We recommend dedicating new hardware to run VR-TheWorld due to incompatibility with earlier versions. If you want to use data from an earlier version of VR-TheWorld, you must manually copy the data from your old server to your new server. There is no way to reuse your database from earlier versions of VR-TheWorld. You must manually enter layers and upload their data.

If you want to upgrade a server running an earlier version of VR-TheWorld, you must save your current data and back up your database to an external hard drive. Then, install a new Linux operating system. This ensures that previous installations of VR-TheWorld do not interfere with the upgraded image. After successfully installing a new operating system, please follow the instructions to install VR-TheWorld.

## 2.7. Managing VR-TheWorld Global Imagery Layers

As of March 2024, VR-TheWorld now includes a new global imagery layer, based on Sentinel-2, which is a WebP format layer. WebP layers are only supported by products part of the MAK ONE 2024 release and later. VR-TheWorld still includes the old layer, although it has also been updated to the Sentinel-2 dataset, but it is in JPEG format and only partially tiled.

The two main imagery layers used by the MAK ONE demonstration scenarios and terrains are:

- Raster Layer 142, which is the WebP layer
- Raster Layer 224, which is the JPEG layer

Layer 224 was the imagery primary layer used in the MAK ONE examples until March 2024, when it was replaced by Layer 142. Both layers are marked as **Generate tiles on demand**, and therefore create tiles for areas that were not previously tiled. However, if you know which layers will be used, you can manage the tiles to conserve disk space or tile your specific areas of interest for improved performance.

Layer 142 is a Collection Layer, comprised of a number of other layers. It is mostly tiled, especially for areas that are heavily used in the MAK ONE examples (for example, Southern California and Hawaii). It is globally tiled to LOD 11.

Layer 224 is also a Collection Layer. It is comprised of the Global EOX Sentinel-2 Cloudless 2020 layer (LODs 0-8) and Layer 142 (LODs 9+), essentially making it a mirror of Layer 142. However, each layer requires its own tiles.

If you use only products that are part of the MAK ONE 2024 release and later:

- You do not need Layer 224. If you want, you can select the layer, go to the Tiles tab, and Delete All Tiles.
- If you have specific areas of interest, you may want to choose Layer 142, zoom to that area, use **Shift**+click, drag to draw a box around the area, and then Generate Area to pre-tile that area.

If you use only products prior to the MAK ONE 2024 release:

- Layer 224 will be your primary imagery layer. If you have specific areas of interest, you may want to choose Layer 224, zoom to that area, use **Shift**+click, drag to draw a box around the area, and then Generate Area to pre-tile that area.
- You must not delete the tiles for Layer 142 because tiling 224 uses 142 to generate tiles for 224.

If you use a combination of products released before and after the MAK ONE 2024 release:

- If you have specific areas of interest, you will likely want to tile that area in both 142 and 224.

# 3. Configuring VR-TheWorld

This chapter describes basic configuration and server management tasks.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# 3.1. OpenMapTiles and MapBox GL Styling

VR-TheWorld can use OpenStreetMap (OSM) datasets in the OpenMapTiles schema to render maps using MapBox GL styles. OpenMapTiles is an extensible and open tile schema based on OSM features. A dated snapshot of the OSM data as vector tiles is included with the VR-TheWorld server. Using this dataset and schema, you can use MapBox GL styles to define how to render the various features to produce maps according to your specific design.

VR-TheWorld includes several sample styles, including a Topographic map style used in several MAK ONE examples. Styles are in JSON format and can be edited using any text editor or several available editor products. There are several styles that can be tailored for use with VR-TheWorld, available from Open-source map styles – OpenMapTiles (https://openmaptiles.org/styles)

The OSM data and configuration files are located on the server in */data/added/mbtiles*. The OpenMapTiles dataset, *osm-openmaptiles.mbtiles*, is a symbolic link to a dated version of the processed OSM data. Using this link ensures that the data can be updated, and the link changed, without needing to change referencing styles.

## 3.1.1 Configuring the Tile Server

Rendering OpenMapTiles is supported using an embedded tile server, TileServer GL (https://github.com/maptiler/tileserver-gl). Startup settings for the TileServer GL are defined in the *docker-compose.yml* and the specific configuration for the server, *config.json*, is located in the same directory as the OSM dataset.

The *config.json* is comprised of several sections:

- options:paths - Locations of the fonts, sprites, and styles.
- options:rendererOptions - Number of raster tile renderers per scale factor. The first element is the minimum number of renderers for scale factor 1, the second for scale factor 2, and so on. More renderers will increase memory usage.
- formatOptions - Options for the generation of images in the supported file formats. For JPEG and WebP, the only supported option is quality [0–100].
- Styles - All styles and associated options.

  For each style, the type should be raster. Choose the appropriate format for the rendered tiles. Unless there are reasons for small bounds, the value should be `[-180, -85.0511, 180, 85.0511]` for global datasets. For a Spherical Mercator projection, the bounds are chosen because of limits of the projection.

## 3.1.2 Styling and Rendering Data

VR-TheWorld comes preconfigured with the following styles, which are modified versions of available open-source styles:

- MAK Topographic Style – a MAK-modified version of the open-source OSM Liberty Topo style (https://github.com/thomas-oderud/osm-liberty-topo).
- OSM Bright – a version of the open-source MapBox style (https://github.com/mapbox/osm-bright).

- Positron – a version of the open-source Positron style, which provides a light gray map, useful for overlaying other data (https://github.com/openmaptiles/positron-gl-style).
- Contours – a simple 25 m contour line map that can be overlaid on other image layers.

New styles can be added or derived from these.

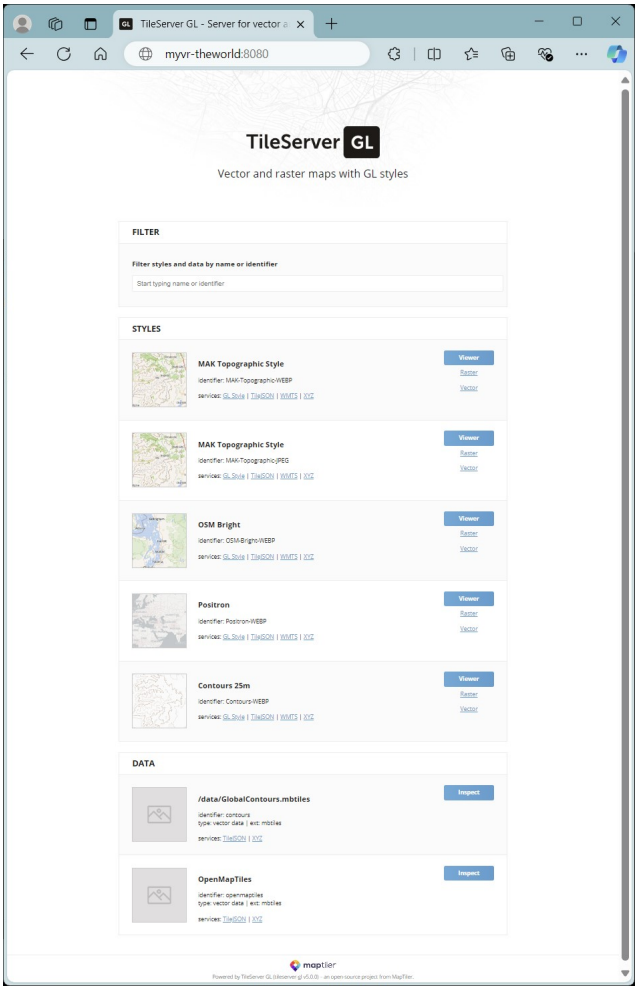
The styles are located in */data/added/mbtiles/MapBoxGLStyle*. Styles can use fonts (glyphs) and symbols (sprites), which are located in */data/added/mbtiles/MapBoxGLStyle/resources*. Fonts or Sprite sets can be added to the ones shipped with the server. Fonts must be signed-distance-field glyph sets in PBF format. Several fonts are provided with VR-TheWorld, but a useful tool for converting fonts to PBF format is the Map Libre Font Maker (https://maplibre.org/font-maker). Sprites are composed of a JSON and a PNG file. There are several sprite sets available, as well as conversion tools from SVG.

When the VR-TheWorld server is running, you can view the active styles and information about each using the local TileServer GL webpage:

http://localhost:8080/ or http://(your-server-name):8080/

You can configure the port in the *docker-compose.yml* file.

**Figure 2. TileServer GL**




## 3.1.3 Using MapBox GL Styled-Map as VR-TheWorld Layers

You can add MapBox GL Styled-maps as a Raster layer by creating a new Raster XYZ layer. XYZ Tiles is a method of expressing map tile mosaics, indexed by (x,y) offsets and zoom levels (z). XYZ Tiles use a REST interface where a request for a tile includes the desired map layer, x, y and z values as part of the URL.

URLs are of the format:

```
http://tileservergl:8080/styles/[style-name]/[tile-size]/
  {z}/{x}/{-y}.[format]
```

where:

- *style-name* is the name of the defined in the server configuration.
- *tile-size* is the desired size of the tile.
- *format* is the tile image format, which would be one of webp, jpg, or png.

The `{z}/{x}/{-y}` notation is required by the VR-theWorld Raster layer. Also, the port is always 8080 because that is used inside the Docker container and is independent of the external mapping that you may have configured in your *docker-compose.yml*. Note that the URL shown for XYZ in the tileserver-gl webpage is not correctly formatted for the VR-TheWorld layers, therefore you cannot simply cut and paste what is displayed there.

For tile sizes, choose either 256 or 512. Both 256x256 and 512x512 have exactly the same content scale (identical pixel size of features and labels). The only difference is in the covered area.

In addition to the different tile sizes, it is also possible to request a HiDPI (also called "retina") version of the tile by adding a `@2x` suffix before the extension:

```
http://tileservergl:8080/styles/[style-name]/[tile-size]/
  {z}/{x}/{-y}@2x.[format]
```

Both the default and the HiDPI versions display the same area and content, but the HiDPI version simply contains more pixels.

Raster Layers from the tile server must be set as a Spherical Mercator projection. The tile size of the tileservergl URL is the tile size of the Raster layer. The tile image format in the URL is the tile format for the Raster layer.

Resulting Raster layers are like any other Imagery layer and handle the same in the MAK ONE configuration files.

### 3.1.4 Default Styles Available for Use as VR-TheWorld Layers

The following styles and formats are defined in the default configuration and can be used with VR-TheWorld Raster XYZ layers. Sizes can be 256 or 512. You can choose either default or retina resolution.

The available styles include:

1. MAK Topographic Style (WebP)

   A basic map that also includes contour lines, in WebP format.

**Figure 3. MAK Topographic**


```
http://tileservergl:8080/styles/MAK-Topographic-WEBP/256/
  {z}/{x}/{-y}@.webp
```

```
http://tileservergl:8080/styles/MAK-Topographic-WEBP/256/
  {z}/{x}/{-y}@2x.webp
http://tileservergl:8080/styles/MAK-Topographic-WEBP/512/
  {z}/{x}/{-y}.webp
http://tileservergl:8080/styles/MAK-Topographic-WEBP/512/
  {z}/{x}/{-y}@2x.webp
```

2. MAK Topographic Style (JPEG)

   Same as above but in JPEG format.

```
http://tileservergl:8080/styles/MAK-Topographic-JPEG/256/
  {z}/{x}/{-y}@. jpg
http://tileservergl:8080/styles/MAK-Topographic-JPEG/256/
  {z}/{x}/{-y}@2x. jpg
http://tileservergl:8080/styles/MAK-Topographic-JPEG/512/
  {z}/{x}/{-y}. jpg
http://tileservergl:8080/styles/MAK-Topographic-JPEG/512/
  {z}/{x}/{-y}@2x. jpg
```

3. OSM Bright (JPEG)

   A basic map style based on the open-source style, in JPEG format.

**Figure 4. OSM Bright**


```
http://tileservergl:8080/styles/OSM-Bright-WEBP/256/
  {z}/{x}/{-y}@.jpg
http://tileservergl:8080/styles/OSM-Bright-WEBP/256/
  {z}/{x}/{-y}@2x.jpg
http://tileservergl:8080/styles/OSM-Bright-WEBP/512/
  {z}/{x}/{-y}. jpg
http://tileservergl:8080/styles/OSM-Bright-WEBP/512/
  {z}/{x}/{-y}@2x. jpg
```

4. Positron (WebP)

   A light base map, ideal as a non-obtrusive basemap for your data visualizations, based on the open-source style, in WebP format.

**Figure 5. Positron**


```
http://tileservergl:8080/styles/Positron-WEBP/256/
  {z}/{x}/{-y}@.webp
http://tileservergl:8080/styles/Positron-WEBP/256/
  {z}/{x}/{-y}@2x.webp
http://tileservergl:8080/styles/Positron-WEBP/512/
  {z}/{x}/{-y}.webp
http://tileservergl:8080/styles/Positron-WEBP/512/
  {z}/{x}/{-y}@2x.webp
```

5. Contours (WebP)

   A style that only includes 25 m contours, which can be combined with other layers.

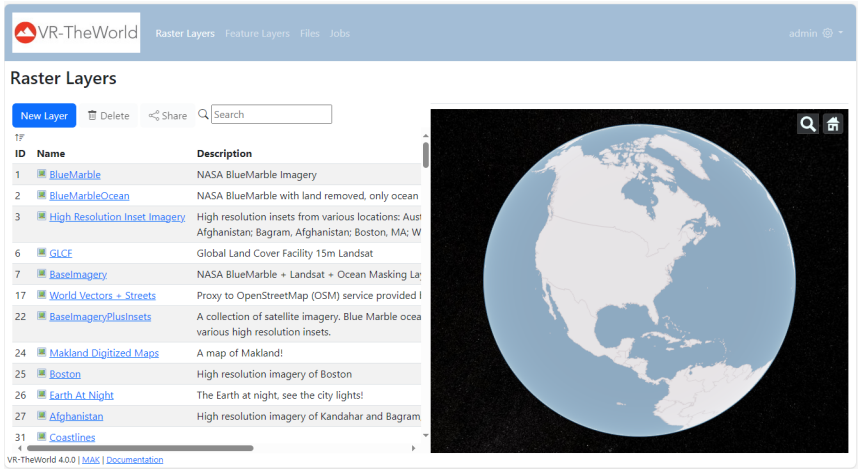
**Figure 6. Contours**

```
http://tileservergl:8080/styles/Contours-WEBP/256/
  {z}/{x}/{-y}@.webp
http://tileservergl:8080/styles/Contours-WEBP/256/
  {z}/{x}/{-y}@2x.webp
http://tileservergl:8080/styles/Contours-WEBP/512/
  {z}/{x}/{-y}.webp
http://tileservergl:8080/styles/Contours-WEBP/512/
  {z}/{x}/{-y}@2x.webp
```

## 3.2. VR-TheWorld Browser GUI

VR-TheWorld administrators configure VR-TheWorld through the browser interface.

**Figure 7. VR-TheWorld administrator view**




## 3.3. Logging In to VR-TheWorld

➤ **To log in to the server:**

1. Open a web browser.
2. Point the browser to http://*host*/vr-theworld, where *host* can be the IP address of the server, localhost if you are running on the server, or the hostname of the server PC.

**Figure 8. VR-TheWorld**


3. The default username is `admin`. The default password is also `admin`. It is recommended that you change the password the first time you log in.
4. Configure the server, as described in the rest of this chapter.

> If you plan to use your VR-TheWorld server with the MAK ONE products, remap vr-theworld.com to the IP address of your server. To do this, edit your */etc/hosts* file and add the line:
>
> `your-IP-address vr-theworld.com`

## 3.3.1 Changing the Admin Password

➤ **To change the admin password:**

1. Log in to VR-TheWorld.
2. In the upper-right corner, open the Admin menu and then click Change Password. The Change Password page opens.
3. Optionally, edit the username.
4. Type the current password.
5. Type the new password and confirm it.
6. Click Save.

### Forgotten Password

If you ever forget your password, you can change it by accessing the server PC and using the command line.

➤ **To reset your password:**

1. Open a Command Tool or terminal window.
2. Change directory to the *VRTheWorld* directory.
3. Run the following command:

   `docker-compose exec readymap ./manage.py changepassword USERNAME`

## 3.3.2 Logging Out of VR-TheWorld

➤ To log out of VR-TheWorld, open the Admin menu and then click Logout.

# 4. Working with Layers

This chapter describes how to create and edit layers.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# 4.1. Layers

VR-TheWorld supports raster layers and feature layers. Raster layers can contain image data or elevation data. Feature layers contain feature data.

# 4.2. Creating and Editing Raster Layers

VR-TheWorld supports the following types of raster layers:

- Local layer. A local layer uses the files on the server.
- Remote layer. A remote layer connects to another file server and makes it seem as if the files are coming from VR-TheWorld.
- Collection layer. A Collection layer is a layer that is made up of other layers. Collection layers are more configurable than other layers and may improve performance because there is one place to look for all of the required data.

Layers are made up of files. In addition to the files provided with VR-TheWorld, you can upload your own data for storage on the server. Image files must be georeferenced, such as GeoTIFFs.

## 4.2.1 Creating a Raster Layer

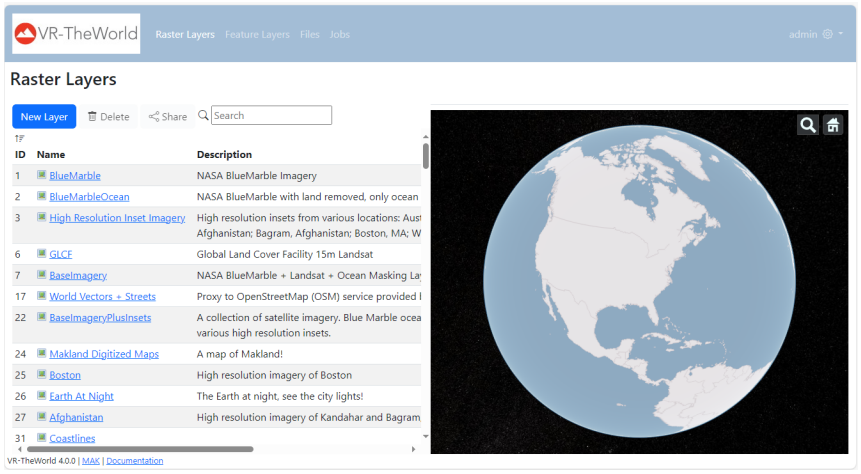
You can create the following types of raster layers:

- Local. A local layer.
- WMS. A remote layer.
- Collection. A composite layer.
- Temporal. A time series of multiple layers.
- Mapnik. Renders tiles from a Mapnik map file.
- MBTiles. Render tiles from a MBTiles file. Note that this only supports Raster MBTiles files.
- XYZ. Uses proxy data from a tiled imagery service using a URL template.

➤ **To create a raster layer:**

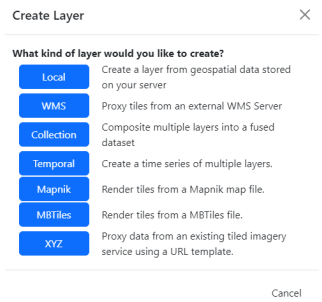
1. Connect to VR-TheWorld.
2. Log in as administrator.
3. Select the Raster Layers tab.

**Figure 9. Raster Layers tab**



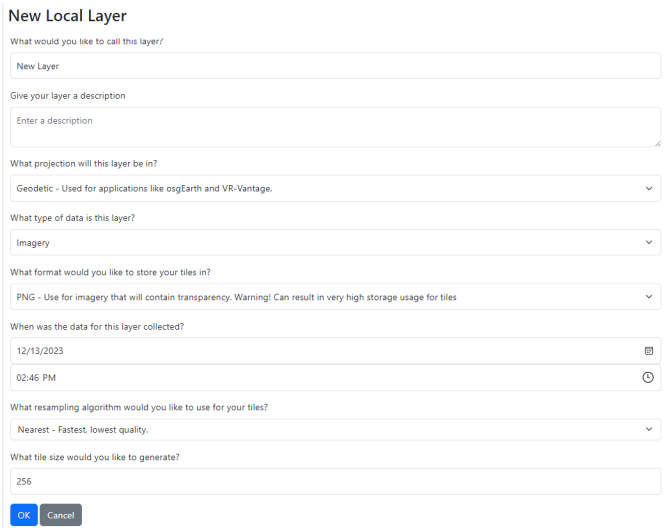

4. Click New Layer. The Create Layer window opens (Figure 10), It lists the types of layers that you can create with brief descriptions.

**Figure 10. Create Layer window**




5. Click the button for the type of layer you want to create. The browser displays a layer creation dialog for the layer.

**Figure 11. Edit local image layer**




6. Fill in the attributes for the layer. For details about the attributes of each layer type, see "4.2.2 Layer Attributes" below.
7. If you are creating a Collection layer, add layers.
8. Click OK.

## 4.2.2 Layer Attributes

The different layer types share several common attributes. Table 3 lists the common attributes and the layer-specific attributes.

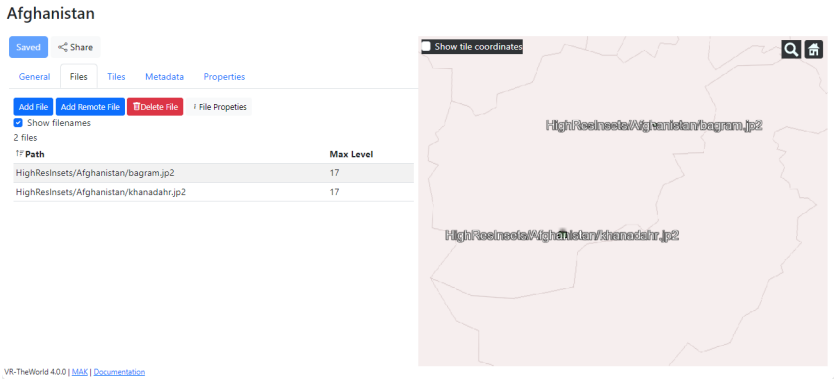
**Table 3. Layer attributes**

| Wizard Page | Applicable Layer | Attribute |
|---|---|---|
| Name | All | |
| Description | All | |
| Projection | All | Geodetic or Spherical Mercator. |
| Data type | Local, Temporal | Imagery or elevation. |
| Tile Storage | Local, Collection, Mapnik | Imagery: PNG, JPEG, WEBP, BASIS, or TIFF.<br>Elevation: Tiff, Cesium Quantized Mesh, or MapBox Terrain RGB. |
| Date/Time | Local | The date and time when the data was collected. |
| Resampling method | Local | Resampling algorithm: Nearest, Bilinear, or Average. |
| Tile Size | Local, WMS, Collection | Size of generated tiles. |
| URL and Layer(s) | WMS | WMS service URL and layers. |

## 4.2.3 Adding Files to a Local Layer

A layer is made up of one or more files. The files are listed when you edit a layer. You can add files to a layer.

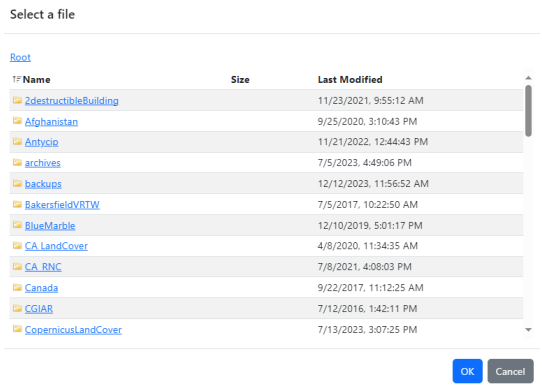
**Figure 12. Layer file list**




➤ **To add files to a local layer:**

1. Enter Edit mode:
   a. Select the Raster Layers list.
   b. Double-click the layer you want to edit.
2. Click the Files tab.
3. Above the file list, click the Add File button (Figure 13). The Select a File dialog box opens.

**Figure 13. Add Files dialog**




4. Select the name of the file you want to add, or select the row to choose a directory from which you want to add all of the files.
5. Click OK. The files you selected are added to the layer.
6. Add more files as desired.
7. Save the layer.

### 4.2.4 Zooming to a File

When you view a layer, you can quickly zoom in to the location of each file.

➤ **To zoom to a file:**

1. Enter Edit mode:
    a. Select the Raster Layers list.
    b. Select the layer you want to edit.
2. Click the Files tab.
3. Select the file that you want to zoom to.
4. Click the Zoom to File button (Figure 13 on the previous page).

### 4.2.5 Viewing the Properties of a File

You can display the properties of the files in a raster layer.

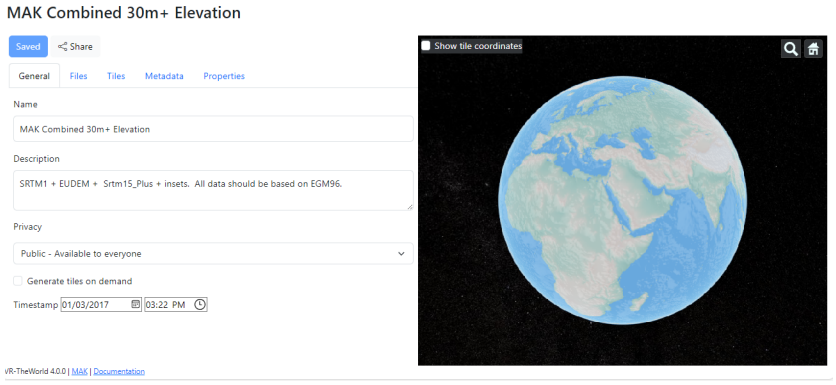
➤ **To display file properties:**

1. Enter Edit mode:
    a. Select the Raster Layers list.
    b. Select the layer you want to edit.
2. Click the Files tab.
3. Select the file that you want to view.
4. Click the File Properties button.

### 4.2.6 Viewing Elevation Layers

When you display an elevation layer, VR-TheWorld displays a shaded relief view of the data with colors the layer based on the elevation (Figure 14).

**Figure 14. Coloring by elevation**



## 4.2.7 Deleting Files from a Local Layer

➤ **To delete files from a local layer:**

1. Enter Edit mode:
    a. Select the Raster Layers list.
    b. Select the layer you want to edit.
2. Click the Files tab.
3. In the file list, select the file you want to delete.
4. Above the file list, click the Delete File button. A confirmation dialog box opens.
5. Click OK.
6. Save the layer.

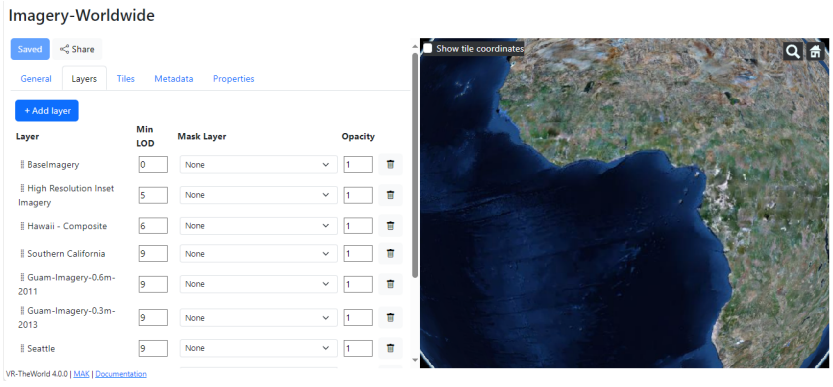
## 4.2.8 Adding Layers to a Collection Layer

A Collection layer is made up of one or more layers. Therefore, when you create a Collection layer, you must specify the layers that it contains.

➤ **To add layers to a Collection layer:**

1. Select the Raster Layers tab.
2. Create a new Collection layer or select an existing Collection layer to enter Edit mode.
3. Select the Layers tab.

**Figure 15. Layers tab**




4. Click the + Add Layer button. The Select Layer dialog box opens.
5. Select a layer in the list.
6. Click OK.

## 4.2.9 Changing the View of a Layer

While editing a layer, you have options for changing the view of the layer:

- Zoom. Press and hold the left mouse button or use the wheel.
- Pan. Press and hold the left mouse button to move the map.
- Jump to a location.
- Jump to the default global view by clicking the Home button.

### Zooming to a Location or Landmark

➤ **To zoom to a specific place, use the Search text box and do one of the following:**

- Type longitude and latitude values and then press **Enter**.
- Type text for an address or landmark and then press **Enter**. Note that the geocoder requires an internet connection to access the Open Street Map service.

## 4.2.10 Tiling Raster Layers

All of the data served by VR-TheWorld is tiled. Tiling is the process of splitting large images into small images for fast loading and viewing within different terrain extents and levels-of-detail (LODs).

➤ **To tile a raster layer:**

1. Select the Raster Layers page.
2. Select the layer you want to tile.
3. Select the Tiles tab.
4. Enter the Min and Max longitude and latitude or use the default values.
5. Enter the Min and Max or use all levels.
6. Select Overwrite Existing Tiles if the data has changed and you want to replace previously generated files.
7. Click Generate Area. The new tiling job is added below, showing the current status.

### Deleting Tiles

You can delete specific tiles by area and/or zoom level. You can delete all of the tiles in a layer by using the default values for the full extent and all zoom levels.

➤ **To delete the tiles in a raster layer:**

1. Select the Raster Layers page.
2. Select the layer with the tiles you want to delete.
3. Select the Tiles tab.
4. Set the appropriate area and zoom values and then click Delete.

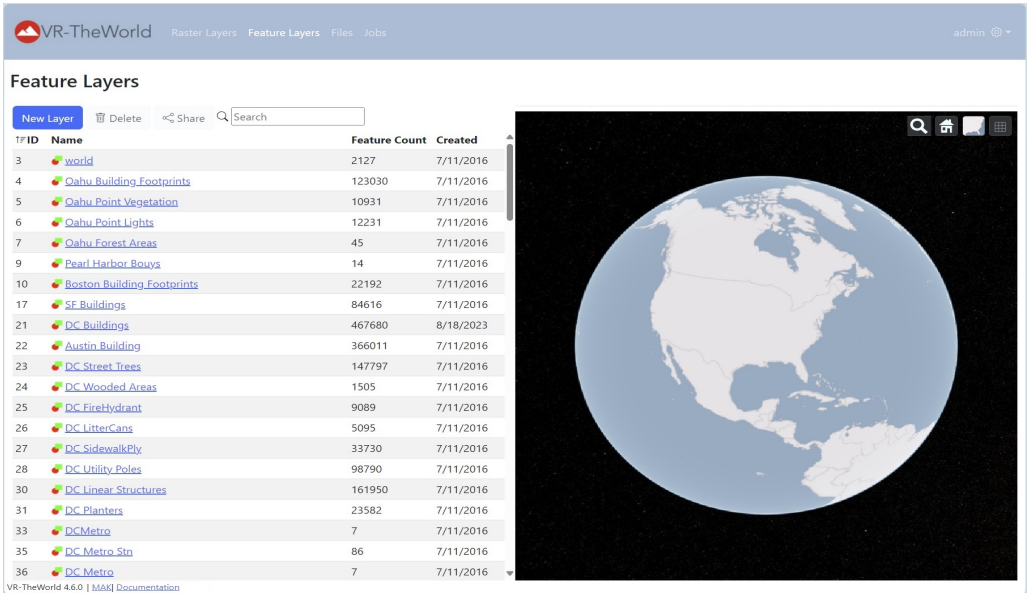
# 4.3. Creating and Editing Feature Layers

Feature layers allow you to add streaming features to your terrain. Feature data is contained in vector features files such as shapefiles (*.shp*).

➤ **To create a feature layer:**

1. Select the Feature Layers tab.

**Figure 16. Feature layer tab**




2. Click New Layer. The New Feature Layer screen is displayed.
3. Enter a name for the layer.
4. Optionally, type a description.
5. Select a file for this layer and then click OK. The Layer field gets filled in from data in the file.

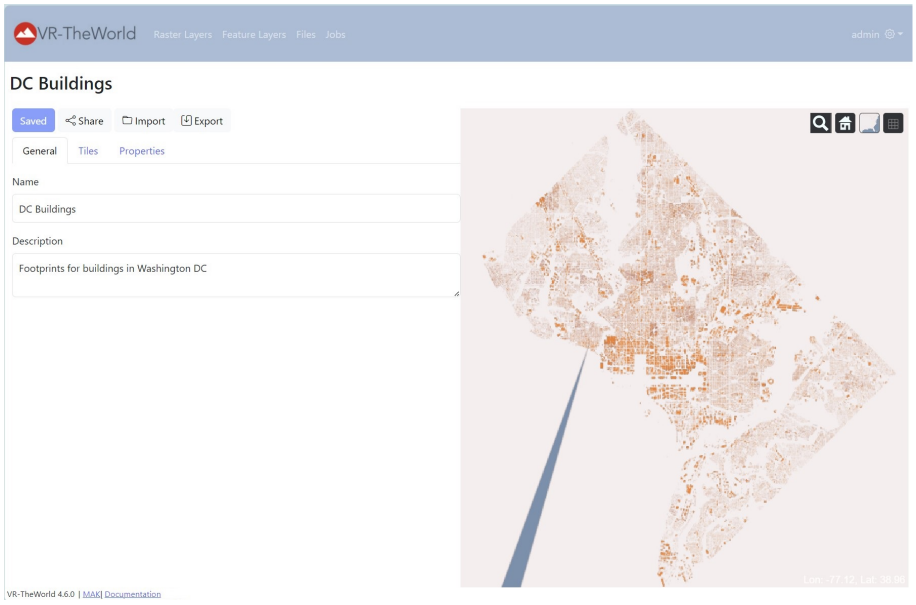
## 4.3.1 Editing a Feature Layer

You can change the name and description of a feature layer and specify parameters for tiling it. You can also change the feature (shapefile, geopackage, and so on) used to create the feature layer.

➤ **To edit a feature layer:**

1. Select the Feature Layers page.
2. Select the feature layer that you want to edit. Information about the layer displays.

**Figure 17. Feature layer selected**




3. Change the name or description.
4. If you want to change the feature source, click the Import button to access the page to select the new file. After changing the source, you must retile the layer.
5. Click Save.

## 4.3.2 Tiling Feature Layers

You can create tiles for the Tiling Feature Service (TFS). Tiling a feature layer serves a different purpose than tiling raster layers. When you tile a feature layer, you specify the order in which features are loaded. For example, you could specify that features above a certain height get loaded first, so that as you approach a city, the skyline becomes visible before smaller buildings do. If you do not tile a feature layer, features are loaded randomly, which may not provide the ideal visual experience.

Feature tiling is optional but recommended for the best performance with the MAK ONE applications (VR-Vantage, VR-Forces, and VR-Engage).

The feature tiling generates a quadtree that starts with a single tile that encompasses the bounds of the entire feature dataset. The Max Features option is the maximum number of features to place in a quadtree tile. Therefore, if you pick 500 and sort by 'height', the tallest 500 buildings go into the first cell, then the next tallest 500 (in each child cell) are placed, and so on.

The First Level specifies the first level in the quadtree that features actually start to appear. For example, if you had a worldwide shapefile of buildings, you do not really need the tallest 500 buildings in the world to appear at a global view. If you picked level 10 as your first level, you would not see buildings start to appear until you zoomed down close enough for level 10 to be visible.

If you choose a First Level greater than 0, it also defines how the data is spatial organized. For example, if you choose First Level = 1, the area covered by the feature is divided into 4 tiles. If you choose Max features = 500 and sort by "height", each tile has the 500

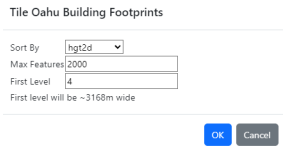
hundred tallest buildings that can be found in that tile. If more than 500 features are found in that tile, it is subdivided into 4 quadrants and the process is repeated until all features in the tile have been added to a tile. This process is repeated for each of the other 3 tiles in level 1.

When you choose the First Level, the dialog displays the estimated tiles size for each tile at that level. For optimal VR-Forces performance, use a flat hierarchy (all features fit into a single level) and check that tiles are small enough, as a combination of number of features per tile and geographic size, to ensure that loading the tile does not take a long time.

➤ **To tile a feature layer:**

1. Select the Feature Layers page.
2. Select the feature layer that you want to tile.
3. Select the Tiles tab.
4. Click Tile Layer. The Tile Layer dialog box opens.

**Figure 18. Tile feature layer dialog box**




5. In the Sort By drop-down list, select the attribute to sort by.
6. In the Max Features box, specify the maximum number of features to place in a quadtree tile.
7. In the First Level box, specify the first level in the quadtree at which features start to appear.
8. Click OK.

## 4.4. Viewing the Properties of a Layer

You can view the properties of a raster layer or feature layer.

➤ **To view the properties of a layer:**

1. Select the Raster Layers page or Feature Layers page.
2. Select the layer with the properties that you want to view.
3. Select the Properties tab.

## 4.5. Searching Layers

You can search for a specific layer using any text string that is part of the ID, Name, Description, or Type columns. You can also sort the columns for clicking the column name.

➤ To search for a layer, type a text string in the Search field.

## 4.6. Deleting a Layer

This procedure applies to raster layers and feature layers.

➤ **To delete a layer:**

1. Select the Raster Layers or Feature Layers page.
2. Select the layer you want to delete.
3. Click the Delete button. A confirmation dialog box opens.
4. Click OK.

## 4.7. Exporting a Subset of a Raster Layer

VR-TheWorld Raster layers can be accessed by the MAK ONE products using a URL referenced in a .earth file. However, there are some use cases where there is a need to have a disconnected version of the application, where VR-TheWorld may not be accessible, and a local terrain is necessary. VR-TheWorld can export a subset of a layer, in MBTiles format, which can be used as part of a local terrain configuration.

Note that some of the data sources used in VR-TheWorld are licensed only for use as part of the VR-TheWorld server and by the MAK ONE products (for example, the EOX Sentinel-2 Cloudless 2020 dataset), so the data cannot be extracted and distributed for use in other systems. However, if the use case is that the disconnected state of the application is temporary or special-purpose use of the system that would also have the ability to connect to a licensed VR-TheWorld, then extracting a subset of the VR-TheWorld data does not violate the EULA.

Extracting a subset of a Raster layer is the same process as tiling the data.

1. Select the layer and the Tiles tab.
2. Select the area to extract either by using the mouse (left button and shift) or by entering the coordinates and enter the Min/Max Zoom levels.
3. Click the Export Area button.

A new Export tiles job will be added to the lift, showing the % complete. When the job is a complete a download icon (☁)displays. Select the icon to download the generated MBTiles file. Alternatively, you can access the file from the Files tab and go to the exports folder. Once downloaded, you can delete from the Job line using the **Actions > Delete** or by selecting the file in the File, exports view.

## 4.8. Exporting a Feature Layer

You can export feature layers for use as local files. You can access the original Source feature listed in the Properties tab by locating the referenced file in the Files tab. However, there is also an Export capability that coverts and exports the feature directly.

1. For the Feature layer, select the Export button.
2. Select the Output format and click OK. The exporting % displays.
3. When it reaches 100%, go to the Files tab and exports folder.

4. Look for the *feature_export_<layer>.<format>* file that was generated.
5. Select the file link to download.
6. Once you have downloaded the file, select the line and **Actions > Delete** to remove it.

Feature layers are exported as the entire feature. If you need a subset, you can use a standard GIS tool, like QGIS or esri ArcGIS, or the GDAL/OGR tools to clip to a specific extent.

## 4.9. Exporting a Subset of OpenStreetMap Features

VR-TheWorld includes snapshots of the OpenStreetMap (OSM) features in MBTiles format. The files are located in the */data/added/mbtiles* directory.

There are some use cases where there is a need to have a disconnected version of the application—where VR-TheWorld may not be accessible—and a local terrain is necessary. VR-TheWorld can export a subset of a Raster layer, in MBTiles format, which you can use as part of a local terrain configuration. You can also download and use the full OSM MBTiles datasets. However, if you want to create a subset of the OSM data that matches your specific Area of Interest (AOI), VR-TheWorld includes a Python script that enables you to generate a subset MBTiles file. The script, *extract_mbtiles.py*, is located in */data/added/mbtiles/extract_mbtiles*.

You must install Python on the server hardware. The script runs on the local system in a console window and there is no access through the VR-TheWorld GUI.

The syntax for the script is:

```
  extract_mbtiles.py [-h] --min-zoom min_zoom --max-zoom max_zoom
--region min_long min_lat max_long max_lat --source input_file
--destination output_file
```

Table describes the arguments.

**Table 4. extract_mbtiles.py arguments**

| Argument | Description |
|---|---|
| `-h` | Optionally, use this to print out the usage line. |
| `--min-zoom` *min_zoom* | Specifies the minimum zoom level to export. |
| `--max-zoom` *max_zoom* | Specifies the maximum zoom level to export. |
| `--region` *min_long min_lat max_long max_lat* | Specifies the extents of the area to export. |
| `--source` *input_file* | Specifies the input source MBTiles file. |
| `--destination` *output_file* | Specifies the output source MBTiles file. |

# 5. Managing Files

This chapter describes how to manage the files on the server.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## 5.1. Managing Files Overview

VR-TheWorld has almost 4 TB of terrain data. You may have additional terrain data that you want to serve using VR-TheWorld. You can add your data to the server to make it available through VR-TheWorld.

VR-TheWorld supports these raster file formats:

- MRSID
- GDAL virtual
- Geotiff
- JPEG 2000
- DEM
- DTED 0 - 5
- Arcinfo Binary Grid
- Magellan BLX Topo
- Bathymetry Attributed Grid
- VTP Binary terrain format
- USGS DOQ
- ESRI *.hdr*
- Envisat Image Product
- ERMapper
- FITS
- Erdas Imagine
- National Imagery Transport Files (CIB, CADRG, and so on)
- BSB Nautical chart format

VR-TheWorld supports these vector file formats:

- Shapefile - https://desktop.arcgis.com/en/arcmap/latest/manage-data/shapefiles/what-is-a-shapefile.htm.
- Geopackage - https://www.geopackage.org.
- FlatGeobuf - https://flatgeobuf.org.
- ENC S-57 - https://iho.int/enc-production-s-57
- KML - https://developers.google.com/kml/documentation/kml_tut
- VMAP - https://en.wikipedia.org/wiki/Vector_Map

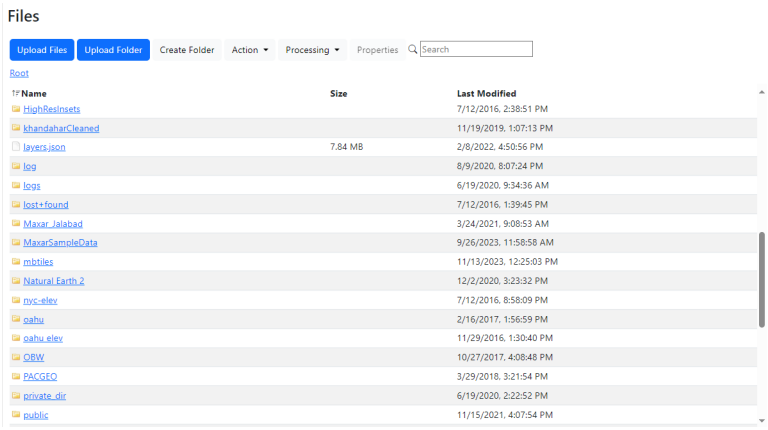
## 5.2. Creating a Folder

VR-TheWorld stores files in folders (directories). You can create new folders for your data or store data in existing folders.

➤ **To create a folder:**

1. Log in as administrator.
2. Select the Files tab.

**Figure 19. Files tab**




3. Click Create Folder. The Create Folder dialog box opens.
4. Type a name for the new folder.
5. Click OK. The folder is added to the files list.

## 5.3. Uploading Files

You can upload individual files and compressed files. If you upload a *.zip*, *.tar*, or *.tar.gz* file, VR-TheWorld automatically uncompresses it.

➤ **To upload a file:**

1. Log in as administrator.
2. Select the Files page.
3. Select the folder into which you want to upload a file.
4. Click Upload. A file selection dialog box opens.
5. Select the files you want to upload. (You can select multiple files using standard file selection methods.)
6. Click Open. VR-TheWorld provides feedback about the progress of the upload process.

## 5.4. Downloading Files

You can download files from the server to a local computer.

➤ **To download a file:**

1. Log in as administrator.
2. Select the Files page.

3. Select the file you want to download.
4. Click **Action > Download**.

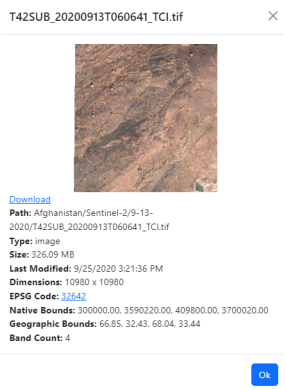
## 5.5. Viewing File Properties

VR-TheWorld can display information about the files in the database, such as the filename, pathname, type, size, and so on.

➤ **To display information about a file:**

1. Select the Files page.
2. Select the file for which you want to view information.
3. Click the Properties button. File properties display.

**Figure 20. File properties**




## 5.6. Deleting Files

➤ **To delete a file:**

1. Log in as administrator.
2. Select the Files page.
3. Select the file or folder that you want to delete.
4. Click **Action > Delete**.
5. Confirm the request to delete the file.

## 5.7. Renaming Files

➤ **To rename a file:**

1. Log in as administrator.
2. Select the Files page.
3. Select the file you want to rename.
4. Click **Action > Rename**. The Rename dialog box opens.

5. Type a new name for the file.
6. Click OK.

# 6. Performance Considerations

This chapter describes ways to improve performance for VR-TheWorld.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# 6.1. Maximizing Performance

In most cases, VR-TheWorld performs well out-of-the-box. However, performance will be affected by network performance and the configuration of the application that is streaming the terrain. The issues discussed in the following sections can help you maximize performance.

## 6.1.1 Tile Size

The tile size parameter for imagery controls the pixel size of the image that VR-TheWorld creates during tiling. The number is used both for the length and the width of the tile: if the parameter is 256, the tile will be 256 x 256 pixels. VR-TheWorld can use any number in this field, but if the end application is to be an osgEarth-based application, such as VR-Vantage, or any other 3D application like Google Earth, it is important that the number be a power of 2. This is because the tiles are used as textures in the graphics card. The recommended imagery tile size is 256.

For elevation layers, the default tile size is 257, which enables overlap to avoid gaps between rendered tiles. In the case of elevation, this controls how many points are in the 3D terrain patch that is created from the tile. Elevation tile size cannot be changed.

## 6.1.2 Pre-Tile Layers

If a layer is not tiled, VR-TheWorld generates tiles on the fly and stores them as they are required. This is useful for quickly testing layers and interacting with the data. However, this generating process can cause undesirable slow spots when the client application is moving around the data. If all of the tiles are generated, the server simply needs to look up the tile and return instead of having to render it.

At times it may not be feasible to pre-generate all of the tiles. Tiling tasks can take a long time depending on the detail level and the area covered. In this case, it is often best to generate the lowest levels first. The hardest tiles to generate are the overview tiles. These tiles tend to have the most source files required for every tile. If your data extends to level 18, for example, and if you create a tiling task that does levels 0–12 instead of automatically tiling all levels, you will drastically reduce the length of time the task takes. Every level is roughly 4 times the size of the previous level in terms of numbers of tiles.

This approach means clients will only generate tiles once they zoom in to areas, which typically represent a low number of tiles. While the tiling operation is running, the client can usually still show the lower resolution tiles that are already generated until the higher resolution is available.

## 6.1.3 Collection Layers

Each layer in a map represents a new connection to VR-TheWorld by the client and tiles that must be downloaded for any given area. The client then draws each layer onto the scene. Collection layers allow you to combine layers on the server and have the server perform the task of rendering every layer to generate the final image. The server then caches the rendered tiles like any other layer. This allows the client to make a single connection to the server and only render one tile over a basemap layer instead of rendering multiple layers and downloading multiple tiles. It is not recommended to combine the base global layers such as Base Imagery into Collection layers since the base

layers are very large and this may ultimately cause the base layers to be copied to the Collection layer. A typical map might have a base layer and one or two overlay layers for maximum performance.

### 6.1.4 Files Per Layer

VR-TheWorld can have difficulty when there are more than 1000 source files in a layer. This is due to the tile rendering process and how much memory can be consumed by large numbers of highly compressed source files. If you want to have layers with more than 1000 source files, it is recommended that you split the layer into multiple smaller layers and use a Collection layer to pull the split layers together.

### 6.1.5 Client-Side Caching

If you use VR-Vantage, it caches as much of the VR-TheWorld terrain as it can, which eliminates the need to re-download tiles for areas that have recently been viewed. This is the most dramatic improvement in performance that can be achieved. osgEarth applications can add caching to their earth file by adding a `cache` block to the `options` block.

### 6.1.6 Feature Attributes

When using features, it is best to upload feature data sets that match the client tasks as closely as possible. When a client connects to VR-TheWorld for features, it downloads all of the feature attributes associated with the feature. If unused attributes are removed from the feature data set before uploading to VR-TheWorld then they will not be downloaded by the clients. This in turn makes the size of the feature tiles smaller and quicker to download.

### 6.1.7 Controlling where Paging Is Handled

If you include a <level> block in the <layout> element of an earth file, the entire dataset is downloaded from the server at once and all of the paging is done locally, ignoring any pre-tiling done on the server. Therefore, do not include a <level> block if you have a large data set. The layout block should look like:

```
<layout>
  <tile_size_factor>5</tile_size_factor>
</layout>
```

## 6.2. OSG and osgEarth Environment Variables

You can improve performance for some terrains by configuring these environment variables:

- OSG_MAX_PAGEDLOD specifies the target maximum number of paged LODs to maintain. Default: 200. Set it to a lower value if you need to reduce memory consumption when using paged terrains. (This variable only affects the GUI.)

- GDAL_CACHEMAX specifies the maximum cache size for streaming terrain. The default value is 200 MB, which is often adequate. However, if you are using a highly detailed terrain, increasing the cache size to a larger value, such as 2000, can significantly improve performance.
- You can configure caching in the <cache> element in the earth file or in the OSGEARTH_CACHE_PATH environment variable.

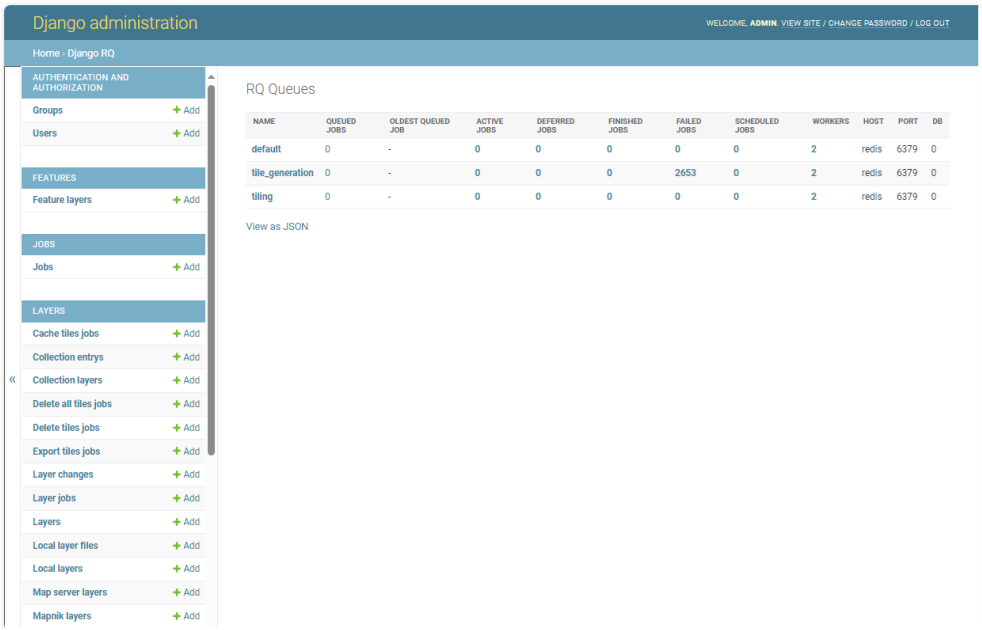
## 6.3. Django Administrator

VR-TheWorld incorporates a Django Administrator interface. This enables the admin to view, change, and manage a number of VR-TheWorld services. This includes:

- View and manage tiling generation queues.
- Manage aspects of layers not accessible in the VR-TheWorld GUI.
- Manage users and groups.
- Manage processing jobs.

➤ To access the Django administration GUI, open a web browser and then go to http://*your-IP-address*/vr-theworld/django-rq.

**Figure 21. Django administration GUI**




## 6.4. Viewing Log Files

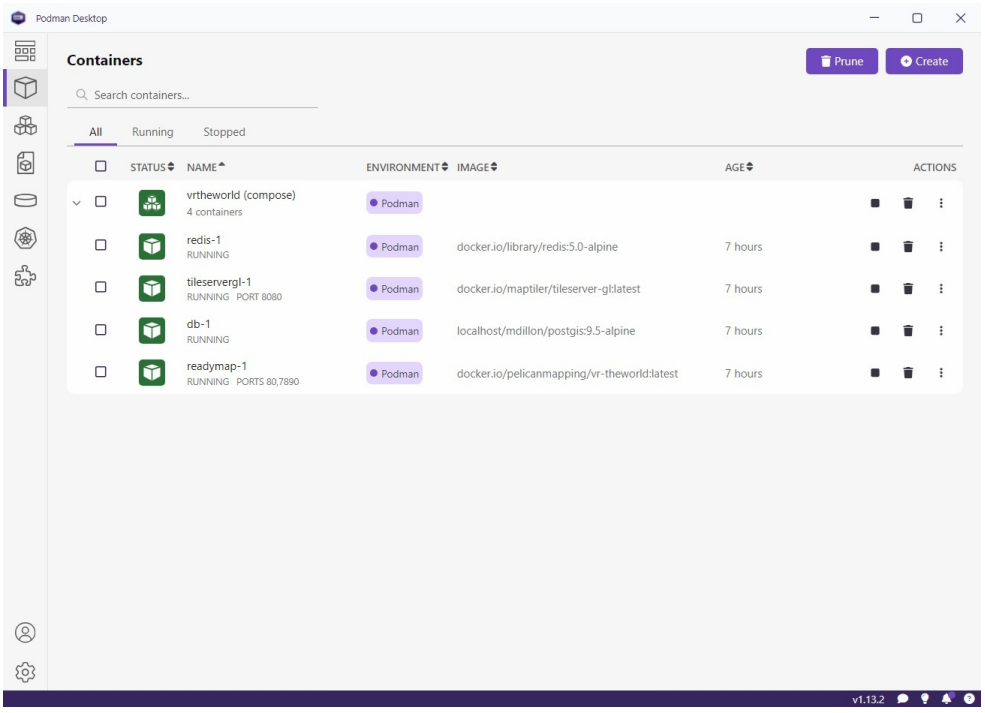
VR-TheWorld maintains several log files to view server status. There are several methods to view the log files.

### 6.4.1 Viewing Logs Using Docker or Podman Desktop

If you have installed Docker or Podman Desktop, you can use that GUI to view the logs. To access the Docker or Podman Desktop, you must be logged into the server.

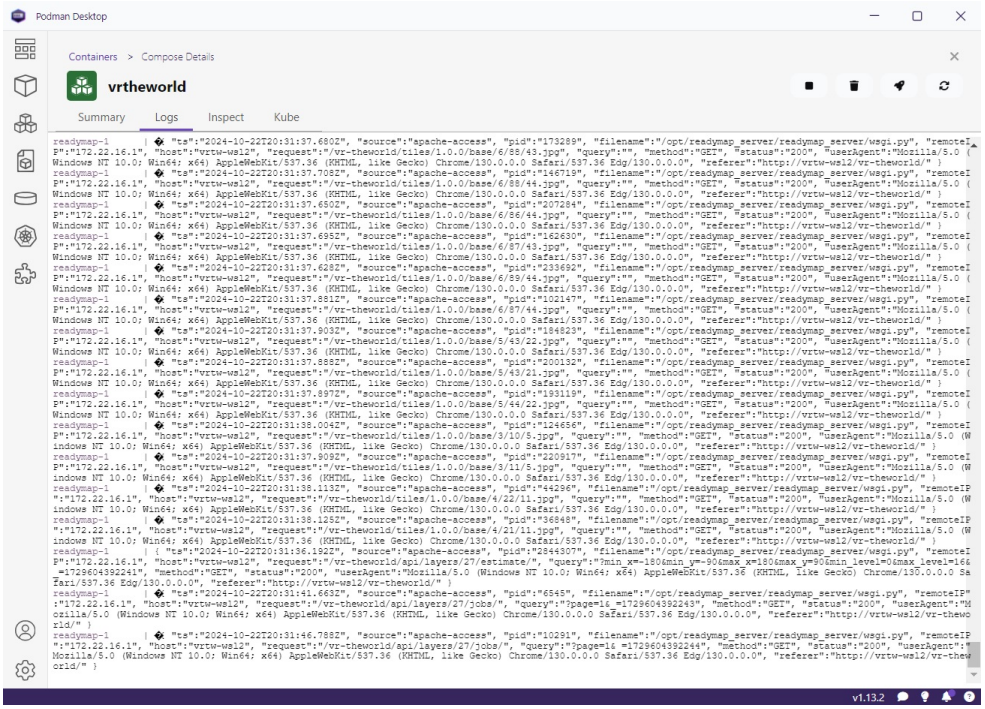
For example, from the Podman Desktop for Windows GUI, you can select the Containers tab to see all VR-TheWorld components.

**Figure 22. Podman Desktop, Containers tab**




You can select the vrtheworld line and access the logs for all components or select the individual components to see their specific logs.

**Figure 23. Podman Desktop, log details**



### 6.4.2 Viewing Logs on a Console Command Line

You can display the logs on the command line of a terminal window.

➤ **To display the logs on a command line:**

1. Open a terminal window to your VR-TheWorld server.
2. Change directory (`cd`) to the */data/VRTheWorld* directory.
3. Type `docker-compose logs --follow readymap`

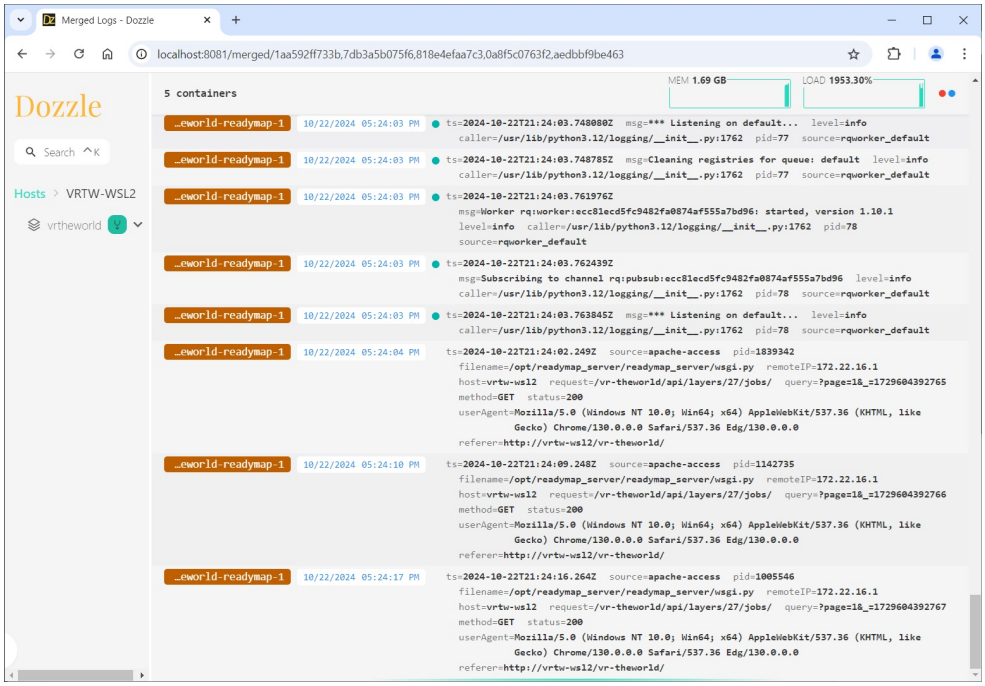
   The log writes to the terminal window until canceled.

### 6.4.3 Viewing Logs Using a Browser

By default, the VR-TheWorld configuration uses Dozzle to provide a browser-based way to view the logs. Dozzle can be installed with the other VR-TheWorld components and accessed on a specific port. By default, *docker-compose.yml* uses port 8081, but you can change that by editing the configuration. Be sure that the port you choose is open in your firewall.

To access the Dozzle logs, you can use any browser to access http://localhost:8081/ or http://*(your-server-name)*:8081/.

**Figure 24. Viewing logs with Dozzle**




Using the Dozzle GUI, you can view merged or individual logs and search for specific keywords.

# A. Terrain Sources

This appendix lists the source for the data used by VR-TheWorld.

A.1. Terrain Sources ..... 76

# A.1. Terrain Sources

Table 5 lists the terrains installed by VR-TheWorld and details about them. Table 6 lists the source material that make up the MAK Combined 30 m+ Elevation Layer.

**Table 5. VR-TheWorld data sources**

| Layer | | Details |
|---|---|---|
| EOX Sentinel-2 Cloudless 2020 | Source | MAK Technologies |
| | Website | https://eox.at |
| | Comments | Global imagery, LODs 0-13, 10 m resolution. For more details about the source data, see https://s2maps.eu by EOX IT Services GmbH. Contains modified Copernicus Sentinel data 2020. |
| | Layer type | Local. |
| Base Imagery DC inset | Source | MAK Technologies |
| | Website | https://opendata.dc.gov |
| | Comments | District of Columbia GIS Program 2015 Orthophoto. |
| | Layer type | Local. |
| Base Imagery Afghanistan inset | Source | Pelican Mapping |
| | Website | http://mapserver.cmf.nrl.navy.mil/ |
| | Comments | Sourced from Project Rampant Lion 1 |
| | Layer type | Tile only. |
| 90 m elevation | Source | Pelican Mapping |
| | Website | http://srtm.csi.cgiar.org/ http://topex.ucsd.edu/WWW_html/srtm30_plus.html |
| | Comments | Sourced from CGIAR. The 90 m elevation posts are ultimately from the Shuttle Radar Topographic Mission. Bathymetry comes from the Scripps Institute of Oceanography SRTM30PLUS. |
| | Layer type | Local. |
| Amherst | Source | Amherst, Massachusetts, USA |
| | Website | http://www.amherstma.gov/index.aspx?nid=1432 |
| | Comments | |
| | Layer type | Local. |

**Table 5. VR-TheWorld data sources (continued)**

| Layer | | Details |
|---|---|---|
| WAC,SEC, TAC and combined Aeronautical Charts layers | Source | U.S. Federal Aviation Administration (FAA) |
| | Website | http://aeronav.faa.gov/index.asp?xml=aeronav/applications |
| | Comments | Purchased from Mypilotstore.com, then downloaded more from the FAA. |
| | Layer type | Local. |
| Chicago | Source | USGS |
| | Website | http://seamless.usgs.gov/hro.php |
| | Comments | Seamless data warehouse: IL_CookCounty_0.5ft_Color_May_2008_01, IL_CookCounty_0.5ft_Color_May_2008_02, IL_CookCounty_0.5ft_Color_May_2008_03, IL_DupageCounty_0.5ft_Color_May_2008 |
| | Layer type | WMS, locally tiled. |
| Delaware | Source | USGS |
| | Website | http://seamless.usgs.gov/hro.php |
| | Comments | Seamless data warehouse: DE_State_0.25m_Color_Mar_2007 |
| | Layer type | WMS, locally tiled. |
| Harris globe - White Sands, Holloman AFB | Source | Harris Corporation |
| | Website | |
| | Comments | Demonstration layers. |
| | Layer type | Local. |
| Hawaii | Source | Harris Corporation |
| | Website | |
| | Comments | Purchased from Harris. 15 m Hawaiian Islands. |
| | Layer type | Local. |
| HI RNC | Source | U.S. National Oceanic and Atmospheric Administration (NOAA) |
| | Website | http://www.charts.noaa.gov/RNCs/RNCs.shtml |
| | Comments | National Ocean and Atmosphere Administration Office of Coast Survey. |
| | Layer type | Local. |

**Table 5. VR-TheWorld data sources (continued)**

| Layer | | Details |
|---|---|---|
| Honolulu Water imagery | Source | Harris Corporation |
| | Website | |
| | Comments | Purchased from Harris. Blending between 1 ft and 15 m coastline for south Oahu. |
| | Layer type | Local. |
| Kandahar | Source | MAK |
| | Website | www.mak.com (Source data is not available on the web site.) |
| | Comments | MAK's hand modeled VR-Village inset into the Project Lion sourced Kandahar image. |
| | Layer type | Local. |
| Long Island | Source | USGS |
| | Website | http://seamless.usgs.gov/hro.php |
| | Comments | Seamless data warehouse: NY_StateLongIsland_0.5ft_Color_Apr_2007 |
| | Layer type | WMS, locally tiled. |
| Mass15 and 30 cm | Source | Massachusetts Geographic Information System (MassGIS) |
| | Website | https://www.mass.gov/info-details/massgis-data-2021-aerial-imagery |
| | Comments | 2021 aerial imagery. |
| | Layer type | Local. |
| Miami | Source | USGS |
| | Website | http://seamless.usgs.gov/hro.php |
| | Comments | Seamless data warehouse: FL_DadeCounty_1.0ft_Color_Jan_2009 |
| | Layer type | WMS, locally tiled. |
| NAIP | Source | U.S. Department of Agriculture (USDA) |
| | Website | http://seamless.usgs.gov/naip.php |
| | Comments | Seamless data warehouse. |
| | Layer type | WMS, partially locally tiled. |
| nexrad | Source | Iowa State University |
| | Website | http://mesonet.agron.iastate.edu/docs/nexrad_composites/ |
| | Comments | Not tiled, because map updates every 45 minutes. |

**Table 5. VR-TheWorld data sources (continued)**

| Layer | | Details |
|---|---|---|
| | Layer type | WMS. |
| NJ | Source | USGS |
| | Website | http://njgin.state.nj.us/ortho2007/ |
| | Comments | Originally USGS data downloaded through seamless, but it moved to the New Jersey Geographic Information Network (NJGIN) site. |
| | Layer type | Local. |
| NYC | Source | USGS |
| | Website | http://seamless.usgs.gov/hro.php |
| | Comments | Seamless data warehouse: NY_StateLongIsland_2.0ft_Color_Apr_2008 |
| | Layer type | WMS, locally tiled. |
| Oahu | Source | USGS |
| | Website | http://hawaii.wr.usgs.gov/oahu/index.html |
| | Comments | |
| | Layer type | Local. |
| Oahu DRG | Source | USGS |
| | Website | http://hawaii.wr.usgs.gov/oahu/index.html |
| | Comments | |
| | Layer type | Local. |
| Oahu 10 m DEM | Source | USGS |
| | Website | http://hawaii.wr.usgs.gov/oahu/index.html |
| | Comments | |
| | Layer type | Local. |
| Ocean Route Charts | Source | FAA |
| | Website | http://aeronav.faa.gov/index.asp?xml=aeronav/applications |
| | Comments | |
| | Layer type | Local. |
| Orlando | Source | USGS |
| | Website | http://seamless.usgs.gov/hro.php |
| | Comments | Seamless data warehouse:<br>Orange and Seminola Counties Apr 2008 1f |
| | Layer type | WMS, locally tiled. |
| Ridge Radar | Source | NOAA NWS |

**Table 5. VR-TheWorld data sources (continued)**

| Layer | | Details |
|---|---|---|
| | Website | http://www.nws.noaa.gov/gis/otherpage.htm |
| | Comments | National weather service, live updating, not tiled. |
| | Layer type | WMS |
| San Diego | Source | USGS |
| | Website | |
| | Comments | Probably USGS. |
| | Layer type | Local. |
| US Canada Border | Source | USGS |
| | Website | http://seamless.usgs.gov/hro.php |
| | Comments | Seamless data warehouse:<br>high resolution border imagery. |
| | Layer type | WMS, partially tiled. |
| Boston Buildings | Source | Pelican Mapping |
| | Website | |
| | Comments | Probably from MassGIS, but no longer available on that site. |
| | Layer type | |
| DC buildings | Source | District of Columbia Geographic Information System (DC GIS) |
| | Website | http://data.dc.gov/ |
| | Comments | District of Columbia GIS Program. |
| | Layer type | |
| Oahu Lights | Source | MAK |
| | Website | www.mak.com (Source data is not available on the web site.) |
| | Comments | |
| | Layer type | |
| Oahu Buildings | Source | Honolulu Land Information System (HoLIS) |
| | Website | http://gis.hicentral.com/data.html |
| | Comments | Airport cropped out of data. |
| | Layer type | |
| Oahu Vegetation | Source | MAK |

**Table 5. VR-TheWorld data sources (continued)**

| Layer | | Details |
|---|---|---|
| | Website | www.mak.com (Source data is not available on the web site.) |
| | Comments | |
| | Layer type | |
| Structure NGA | Source | HoLIS |
| | Website | http://gis.hicentral.com/data.html |
| | Comments | Original Oahu buildings. |
| | Layer type | |

**Table 6. Sources for the MAK Combined 30 m+ Elevation Layer**

| Data | Coverage | Description |
|---|---|---|
| SRTM15_ Plus | Global | Global 15 arcsecond (500 m) elevation plus bathymetry.<br>UC San Diego: http://topex.ucsd.edu/WWW_html/srtm30_ plus.html |
| SRTM1 | 60N to 56S worldwide | 1 arc second (30 m) resolution elevation.<br>Date: February 2000.<br>NASA: https://lpdaac.usgs.gov/dataset_ discovery/measures/measures_products_table/srtmgl1_v003<br>Geoprocessing:<br>Converted from Int16 hgt format to Float32 TIF to facilitate merging in the EU-DEM<br>Values = 0 removed |

**Table 6. Sources for the MAK Combined 30 m+ Elevation Layer (continued)**

| Data | Coverage | Description |
|---|---|---|
| EU-DEM | Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kosovo (UNSCR 1244/99), Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia (FYR), Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom | 1 arc second (30 m) resolution elevation.<br>Date: version 1.1, Apr. 2016.<br>Source: http://www.eea.europa.eu/data-and-maps/data/eu-dem<br>Geoprocessing:<br>Projected to WGS84 |

**Table 6. Sources for the MAK Combined 30 m+ Elevation Layer (continued)**

| Data | Coverage | Description |
|---|---|---|
| CDEM v3 | Canada | 0.75 arc second (22 m) resolution elevation.<br>Date: 2012.<br>Source: http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/c40acfba-c722-4be1-862e-146b80be738e.html<br>Geoprocessing:<br>Water removed (0 elevation), Great Lakes water removed (various elevations). |
| Modelo Digital de Elevaciones de la Argentina | Argentina | 30 m resolution elevation.<br>Date: 2000.<br>Source: http://www.ign.gob.ar/NuestrasActividades/Geodesia/ModeloDigitalElevaciones<br>Geoprocessing:<br>Water removed (0 elevation), Files merged for performance. |
| Continuo de Elevaciones Mexicano 3.0 | Continental Mexico | 15 m resolution elevation.<br>Date: 2012.<br>Source: http://www.inegi.org.mx/geo/contenidos/datosrelieve/continental/continuoelevaciones.aspx<br>Geoprocessing:<br>File merged for faster processing. |
| Coastal Relief Model | Coastline of lower 48 states (United States), Hawaii, and Puerto Rico | 3 arc second (90 m) US coastal elevation/bathymetric model.<br>Date: Varies ~2005<br>Source: NOAA.<br>https://www.ngdc.noaa.gov/mgg/coastal/crm.html<br>Geoprocessing:<br>1 arc second southern California, elevation > 0 removed. |
| Tsunami Inundation | West Coast of US and some East Coast locations, plus some Alaska coastline, Puerto Rico, Bermuda, Virgin Islands, Guam, Midway | 10 m coastal continuous elevation and bathymetry (lower resolutions for Alaska and some islands).<br>Date: Varies.<br>Source: https://www.ngdc.noaa.gov/mgg/inundation/tsunami/inundation.html<br>Geoprocessing:<br>Some files merged with 10 m 3DEP. |

**Table 6. Sources for the MAK Combined 30 m+ Elevation Layer (continued)**

| Data | Coverage | Description |
|---|---|---|
| Estuarine Bathymetry | Only used east Coast US in areas not covered by Tsunami Inundation DEMS | 30 m bathymetry of selected US estuarine areas.<br>Date: Varies.<br>Source: http://estuarinebathymetry.noaa.gov/finddata.html<br>Geoprocessing:<br>Values > 0 removed. |
| Great Lakes Bathymetry | Great Lakes (US/Canada | 3 arc second bathymetry of the Great Lakes.<br>Source: https://www.ngdc.noaa.gov/mgg/greatlakes/greatlakes.html.<br>Geoprocessing:<br>Sourced in lake level datum, used Wikipedia to determine lake level for each lake and then converted it to reference the ellipsoid. Lake bathymetry merged into SRTM 30 m. |
| 3DEP 10m | Washington, Oregon, California and Nevada (United States) | 10 m data for US.<br>Source: 3DEP (3D Elevation Program) is the elevation component of the USGS National Map, replacing the NED (National Elevation Dataset).<br>https://viewer.nationalmap.gov/basic/?basemap=b1&category=ned,nedsrc&title=3DEP%20View<br>Date: Varies.<br>Geoprocessing:<br>Areas that cover water are removed to allow for bathymetry. Many files are merged for<br>faster processing. Washington files are merged with the Tsunami Elevation dataset (10 m) and the Puget Sound DEM for continuous elevation and bathymetry. Oregon and California are also merged with the Tsunami Elevation Dataset. |
| 3DEP 1m | San Diego County, greater New York City Area, Boston (US) | 1 m data for San Diego and several other cities.<br>Source: 3DEP (3D Elevation Program) is the elevation component of the USGS National Map, replacing the NED (National Elevation Dataset).<br>https://viewer.nationalmap.gov/basic/?basemap=b1&category=ned,nedsrc&title=3DEP%20View<br>Date: Varies.<br>Geoprocessing:<br>Areas that cover water are removed to allow for bathymetry. Many files are merged for<br>faster processing. |

**Table 6. Sources for the MAK Combined 30 m+ Elevation Layer (continued)**

| Data | Coverage | Description |
|---|---|---|
| Catalina Island | Catalina Island | 5 ft (1.7 m) for Catalina Island, California, USA.<br>Source: Los Angeles County.<br>https://egis3.lacounty.gov/dataportal/2010/02/19/2006-5-foot-1-7m-digital-elevation-model-dem/<br>Geoprocessing:.<br>Removed values less than zero, merged in bathymetry from tsunami inundation, subtracted 1.5 m from all values from 0-2 to remove an anomaly and merge the bathymetry into the land data. Note: at some point may use this source dataset for the rest of LA county. |
| Puget Sound Digital Elevation Model (PSDEM) | Puget Sound (Seattle/ Tacoma, US area) | Finlayson D.P. (2005) Combined bathymetry and topography of the Puget Lowland, Washington State, US.<br>Source: University of Washington School of Oceanography.<br>https://www.ocean.washington.edu/data/pugetsound/psdem2005.html<br>Geoprocessing:<br>Reprojected to WGS84. Bathymetry Merged into the Washington 10 m dem (see 3DEP) |
| MAK's 1 arc second (30m) dataset | World | A combination of all of the 30 m data sources above (SRTM1, EU-DEM with 1 arc second bathymetry sources, but without combining non-30 m sources). This dataset exists (created outside of VR-TheWorld) because VR-TheWorld doesn't allow us to specify an order of precedence for layers of the same resolution. Therefore, all 30 m sources needed to be combined, before being further combined with other-resolution sources.<br>Geoprocessing:<br>GDAL virtual file created out of the SRTM1 and the EUDEM (EUDEM taking precedence for its coverage). Virtual file then split into 100 k x 100 k pixel TIFF files with null data files removed. Overlaid with:<br>Southern California 1 arc second coastal relief model<br>Great lakes bathymetry<br>Estuarine bathymetry |

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