Mars 2020
Three Forks Depot Archive User's Guide

Version 1.0

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1. Overview

This document is a quick start guide to the Mars 2020 Three Forks Depot Archive. This document is intended to give users a basic understanding of the Three Forks Depot Archive, where to find relevant data products and information, and identify any caveats on data collection.

1.1. Three Forks Depot

The Mars 2020 Perseverance rover has been collecting a set of samples for potential future return to Earth through the joint NASA-ESA Mars Sample Return (MSR) Campaign [5]. Near the end of the rover's prime mission, an initial set of 10 samples was placed on the surface of Jezero Crater. This set of samples serves as a backup, in case the primary set of samples cached within the rover are unable to be retrieved for return to Earth. This set of samples and their location are collectively referred to as the "Three Forks Depot" by the Mars 2020 Science Team.

A preliminary set of scientific observations and interpretations of the 10 samples in the Three Forks Depot is included in Volumes 1 and 2 in the Initial Reports collection of the Sample Dossier Archive [10]. In most cases, these observations and interpretations have been revised and expanded on in a number of subsequent publications, not listed here.

1.2. Archive Overview

The Three Forks Depot Archive is intended to record data related to both the construction and documentation of the Three Forks Depot, to allow for future reconstruction of environmental conditions experienced by the sample tubes both during the depot construction process and while sitting on the surface prior to retrieval for return to Earth. The Three Forks Depot Archive is intended to complement the Sample Dossier Archive [10], which records data related to the sample acquisition process.

Much of the data included in the Three Forks Depot Archive is formally archived in other PDS bundles associated with the Mars 2020 mission. As such, where possible the Three Forks Depot Archive references these products by PDS Logical Identifier (LID) and provides context such as the identity of the associated sample tube, instead of archiving a separate copy of existing products.

1.2.1. Site and Drive Indices

Many of the products in the Three Forks Depot Archive refer to a "Site Index" and a "Drive Index", usually just called "Site" and "Drive". These indices are used to keep track of the rover's position on the surface without localizing to any particular coordinate system. The Site Index is periodically incremented to reset one of the local reference frames used for planning, and the Drive Index keeps track of the number of times the rover's wheels have moved since the last Site Index increment. More details on both of these indices can be found in [12].

For the purposes of the Tree Forks Depot Archive, the combination of Site and Drive is used to keep track of events that occurred at the same location. For example, if a sample tube drop occurred at Site 32, Drive 482, then tube documentation images acquired at Site 32, Drive 482 were acquired at the exact same location, but images acquired at Site 32, Drive 494 were acquired after the rover had driven away. For many products generated by Perseverance, the Site and Drive values are included in the product name ([11], Sections 18-19), which can help to correlate products acquired at the same location.

1.3. Three Forks Depot Archive Bundle

The contents of the Three Forks Depot Archive are archived in the PDS as the **mars2020_sample_depot_three_forks** bundle. The bundle contains four collections (**browse**, **data**, **document, miscellaneous**) organized by product type.

The structure of the **mars2020_sample_depot_three_forks** bundle is given in Table 1.

Directory	Contents
mars2020_sample_depot_three_forks	Bundle
browse	Browse Collection
depot	Browse versions of products in **miscellaneous/depot**
mosaics	Browse versions of products in **document/mosaics**
ortho_mosaics/[sample_tube]	Browse versions of products in **data/ortho_mosaics**
data	Data Collection
ortho_mosaics/[sample_tube]	Orthorectified mosaic products associated with each sample tube
sample_drop_events	Products that describe the events that occurred during the drop events for individual sample tubes.
aca_timeline	Timelines of the steps that occurred during the drop events for individual sample tubes.
document	Document Collection
mosaics	Mosaic products covering portions or all of the Three Forks Depot.
papers	Papers published by the Mars 2020 mission describing the Three Forks Depot.
miscellaneous	Miscellaneous
depot	Metadata related to the Three Forks Depot as a whole.
sample_imaging/[sample_tube]	Summaries of imaging products associated with each sample tube.
sample_mesh_files	Summaries of available mesh files associated with each sample tube.
sample_metadata	Metadata related to each sample tube.

Table 1: Three Forks Depot Archive bundle organization

Subdirectories labeled **[sample_tube]** refer to one of ten subdirectories named for an individual sample tube, e.g. **m2020-00164-02_roubion** (see also section 1.4). Their contents are products related to the containing directory that describe a single sample tube.

All products included in the Three Forks Depot Archive are at the “Derived” PDS Processing Level [4].

1.4. Product Naming

Most products in the Three Forks Depot Archive are intended to have short, human-interpretable names that describe their contents.

In many cases, individual products describe a single sample tube, and similar products exist which describe other sample tubes. In these cases, each product's name will typically contain the designation and name of the associated sample tube (e.g. **m2020-00164-02_roubion**). In some cases, the containing subdirectory will also contain the designation and name of the associated sample tube.

The exceptions to this convention are orthorectified mosaic and digital elevation model (DEM) products, found in the **ortho_mosaics** subdirectory of the **data** collection. Orthorectified mosaic and DEM product names follow the M2020 mosaic filename convention ([11], section 18.2), and are organized into subdirectories that contain the designation and name of the associated sample tube.

1.5. Applicable Documents

These publications or websites describe the Planetary Data System Standards used to produce the Three Forks Depot Archive. These documents are archived in the PDS system and are not found specifically in the Three Forks Depot Archive. These documents are revised approximately every six months with each new release of the PDS Information Model. Current and previous versions may be found at the links below.

[1] Planetary Data System Standards Reference, https://pds.nasa.gov/datastandards/documents/sr/current

[2] PDS4 Data Dictionary, https://pds.nasa.gov/datastandards/documents/dd/current

[3] PDS4 Information Model Specification, https://pds.nasa.gov/datastandards/documents/im/current

[4] Data Providers' Handbook: Archiving Guide to the PDS4 Data Standards, https://pds.nasa.gov/datastandards/documents/dph/current

These papers describes in detail the overall Mars 2020 mission, the Sampling and Caching Subsystem, and the various cameras used to acquire image products mentioned in the Three Forks Depot Archive.

[5] Farley, K. A. et al. Mars 2020 Mission Overview. *Space Sci. Rev.*, 216:142, 2020. doi:10.1007/s11214-010-00762-y

[6] Moeller, R. C. et al. The Sampling and Caching Subsystem (SCS) for the Scientific Exploration of Jezero Crater by the Mars 2020 Perseverance Rover. *Space Sci. Rev.*, 217:5, 2021. doi:10.1007/s11214-020-00783-7

[7] Bell III, J. F. et al. The Mars 2020 *Perseverance* Rover Mast Camera Zoom (Mastcam-Z) Multispectral, Stereoscopic Imaging Investigation. *Space Sci. Rev.*, 217:24, 2021. doi:10.1007/s11214-020-00755-x

[8] Bhartia, R. et al. Perseverance's Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals (SHERLOC) Investigation. *Space Sci. Rev.*, 217:58, 2021. doi:10.1007/s11214-021-00812-z

[9] Maki, J. N. et al. The Mars 2020 Engineering Cameras and Microphone on the Perseverance Rover: A Next-Generation Imaging System for Mars Exploration. *Space Sci. Rev.*, 216:137, 2020. doi:10.1007/s11214-020-00765-9

These document or websites are not directly associated with the Three Forks Depot Archive, but provide additional context and are referenced herein.

[10] Mars 2020 Sample Dossier Archive. urn:nasa:pds:mars2020_sample_dossier. https://pds-geosciences.wustl.edu/missions/mars2020/returned_sample_science.htm

[11] Mars 2020 Project Software Interface Specification (SIS): Camera Data Products. urn:nasa:pds:mars2020_mission:document_camera:mars2020_camera_sis.pdf::2.0. https://pds-geosciences.wustl.edu/m2020/urn-nasa-pds-mars2020_mission/document_camera/Mars2020_Camera_SIS.pdf
[12] Mars 2020 Project Software Interface Specification (SIS): Rover PLACES Data Products for PDS. urn:nasa:pds:mars2020_rover_places:document:mars2020_rover_places_pds_sis.pdf. https://pds-geosciences.wustl.edu/m2020/urn-nasa-pds-mars2020_rover_places/document/Mars2020_Rover_PLACES_PDS_SIS.pdf
[13] Mars2020 Observational Product – m20_orbital_map. urn:nasa:pds:mars2020_rover_places_data_maps:m20_orbital_map::8.0. https://pds-geosciences.wustl.edu/m2020/urn-nasa-pds-mars2020_rover_places/data_maps/m20_orbital_map.img
[14] Mastcam-Z's 360° Panorama Collection. https://mastcamz.asu.edu/mastcam-zs-360-panorama-collection/

2. Browse Products

All browse products are found in the **browse** collection (**urn:nasa:pds:mars2020_sample_depot_three_forks:browse**). A full listing of these products is given in Table 2.

Product Name	Product Description	PDS4 Data Type
browse/depot/ m20_orbital_map_three_forks.png	Browse version of miscellaneous/depot/m20_orbital_map_three_forks.tiff.	Encoded_Image (PNG)
browse/mosaics/*	Browse versions of document/mosaics/*	Encoded_Image (PNG)
browse/ortho_mosaics/[sample_tube]/DEM	Browse version of data/ortho_mosaics/[sample_tube]/DEM.	Encoded_Image (PNG)
browse/ortho_mosaics/[sample_tube]/RZS	Browse version of data/ortho_mosaics/[sample_tube]/RZS.	Encoded_Image (PNG)

Table 2: Browse collection product listing

3. Data Products

All data products are found in the **data** collection (**urn:nasa:pds:mars2020_sample_depot_three_forks:data**). A full listing of these products is given in Table 3.

Product Name	Product Description	PDS4 Data Type	Details
data/ortho_mosaics/[sample_tube]/DEM	Orthorectified digital elevation model of each sample tube shortly after tube drop. Identified by the string "DEM" in characters 13-15 of the file name, e.g. "F_LRGB_0667_**DEM**_0320494_ORR_L_07MTELMJ03.img".	Array_3D_Image	Section 3.1
data/ortho_mosaics/[sample_tube]/RZS	Orthorectified mosaic image of each sample tube shortly after tube drop. Identified by the string "RZS" in characters 13-15 of the file name, e.g. "F_LRGB_0667_**RZS**_0320494_ORR_L_07MTELMJ03.img".	Array_3D_Image	Section 3.1
data/sample_drop_events/ sample_drop_timestamps.csv	Summary of timestamps at which each sample tube was formally declared to be on the surface.	Table_Delimited	Section 3.2
data/sample_drop_events/aca_timeline/ [sample_tube]_aca_timeline.csv	Timestamps of events that occurred as each sample tube moved through the Adaptive Caching Assembly (ACA) during tube drop events.	Table_Delimited	Section 3.3

Table 3: Data collection product listing

3.1. Orthorectified DEM/RZS Products

Orthorectified digital elevation models (DEM) and image mosaics (RZS) at an approximate resolution of 0.0025 m/pixel created from Navcam stereo images [9] are included for each sample tube. Browse versions of all such products are included in the Browse collection.

3.2. Sample Drop Timestamps

The Sample Drop Timestamps product lists the times during each tube drop event when the tube was formally declared to be on the ground.

3.3. ACA Timeline

The ACA timeline products list the timestamps of events that occurred as each sample tube moved through the Adaptive Caching Assembly (ACA, [6]) during tube drop events. A high-level overview of the sequence of steps which occur during tube drop events is as follows, with further detail is available in [6]:

- The sample tube is removed from the Sample Tube Storage Assembly (STSA)
- The sample tube is moved to the Vision Station
- The sample tube is imaged by CacheCam
- The sample tube is moved to the Sealing and Drop Off Station
- The sample tube is dropped to the surface

Each product includes a list of commands executed during the tube drop event, the sequence ID from which each command was called, the start and end time of each command (in both SCLK and LMST), the duration in seconds, and the status code (SUCCESS or FAILURE) of each command.

Table 4 summarizes the expected commands that may be observed during tube drop events.

Command Name	Event Description
SCS_ACA_SHA_UNSTOW	The Sample Handling Arm (SHA) is unstowed. Must occur prior to SCS_ACA_FETCH_TUBE_FROM_STORAGE.
SCS_ACA_SS_UNSTOW	The Sealing and Drop Off Station is unstowed. Must occur prior to SCS_ACA_PLACE_TUBE_IN_SS.
SCS_ACA_FETCH_TUBE_FROM_STORAGE	The SHA picks up the sample tube from the STSA and brings it to the Vision Station, where it is imaged by CacheCam.
SCS_ACA_PLACE_TUBE_IN_SS	The SHA brings the sample tube to the Sealing and Drop Off Station.
SCS_ACA_DROPOFF_TUBE	The sample tube is dropped to the surface.
SCS_ACA_SS_STOW	Stows the Sealing and Drop Off Station. Must occur after SCS_ACA_PLACE_TUBE_IN_SS.
SCS_ACA_SHA_STOW	Stows the SHA. Must occur after SCS_ACA_PLACE_TUBE_IN_SS.
SCS_EE_HTR_MAIN_CONTROL	Heater control command for the End Effector (EE) attached to the SHA. May occur multiple times throughout tube drop events.

Table 4: Commands executed during tube drop events

4. Document Products

All document products are found in the **document** collection (**urn:nasa:pds:mars2020_sample_depot_three_forks:document**). A full listing of these products is given in Table 5.

Product Name	Product Description	PDS4 Data Type	Details
document/anomaly_summary.txt	High-level summary of all known anomalies that occurred during Three Forks Depot construction.	Encoded_Byte_Stream (UTF-8 TXT)	Section 4.1
document/User_Guide.pdf	This user guide.	PDF/A	
document/mosaic/mastcam_z_mosaic_*	Mosaic products acquired by Mastcam-Z	Encoded_Image (TIFF) Encoded_Image (PNG)	Section 4.2
document/mosaic/watson_mosaic_sol_684.jpg	Mosaic product acquired by WATSON on sol 684.	Encoded_Image (JPEG)	Section 4.3
document/papers/ Science_Community_Workshop_Report.pdf	"Report of the Science Community Workshop on the proposed First Sample Depot for the Mars Sample Return Campaign", prepared by the MSR Campaign Science Group.	PDF/A	Section 4.4

Table 5: Document collection product listing

4.1. Anomaly Summary

This document summarizes all known anomalies that occurred during Three Forks Depot construction.

4.2. Mastcam-Z Mosaics

Several mosaic products showing the Three Forks Depot were produced as special products by the Mastcam-Z team [7], outside the normal Mastcam-Z processing pipeline. As such, these products are archived here instead of in one of the Mastcam-Z-specific bundles. In some cases, additional versions of these products can be found at [14].

Mastcam-Z mosaic product names share a similar format, denoting the sol (or sol range) on which individual frames were acquired and camera eye (left or right) used to acquire the image frames. For example:

- mastcam_z_mosaic_sol_650_left.png: Mosaic acquired on sol 650 by the left eye
- mastcam_z_mosaic_sols_690_692_right.tif: Mosaic acquired from sols 690-692 by the right eye

Reduced-resolution browse versions of all Mastcam-Z Mosaic products are included in the Browse collection.

4.2.1. Hogwallow Flats Mosaic

Two Mastcam-Z mosaic products were acquired at the "Hogwallow Flats" location a few hundred meters away from Three Forks:

- mastcam_z_mosaic_sols_466_474_left.tif
- mastcam_z_mosaic_sols_466_474_right.tif

These products were included in the archive as the highest-resolution mosaics that show the entirety of the Three Forks Depot from an external perspective. In both mosaics, the Three Forks Depot is approximately located at lines 7500-8000 and samples 88,000-90,000.

4.3. WATSON Mosaic

One mosaic product showing the Three Forks Depot and the Perseverance rover was produced as a special product by the WATSON team [8], outside the normal WATSON processing pipeline. As such, this product is archived here instead of in one of the WATSON-specific bundles. A reduced-resolution browse version of this product is included in the Browse collection.

4.4. Science Community Workshop Report

The Science Community Workshop Report is a report produced following a joint M2020/MSR workshop to assess the samples cached at the Three Forks Depot. The joint workshop aimed to determine whether the planned sample collection was Scientifically-Return Worthy prior to the construction of the Three Forks Depot.

5. Miscellaneous Products

All ancillary products are found in the **miscellaneous** collection (**urn:nasa:pds:mars2020_sample_depot_three_forks:miscellaneous**). A full listing of these products is given in Table 6.

Product Name	Product Description	PDS4 Data Type	Details
miscellaneous/depot/campaign_sols.csv	Summary of the Mars 2020 sol ranges during which Three Forks Depot reconnaissance and creation campaigns occurred.	Table_Delimited	Section 5.1
miscellaneous/depot/depot_mosaics.csv miscellaneous/depot/depot_mosaic_sequences.csv miscellaneous/depot/edlcam_sidewalk_frames.csv	Three related products that summarize available mosaics of the Three Forks Depot.	Table_Delimited	Section 5.2
miscellaneous/depot/ m20_orbital_map_three_forks.tiff	Orbital map of the Three Forks Depot, annotated to show the rover's path during depot creation.	Encoded_Image (TIFF)	Section 5.3
miscellaneous/sample_imaging/[sample_tube]/ [sample_tube]_documentation_images.csv	Summary of all planned documentation images acquired of each sample tube during and shortly after tube drop.	Table_Delimited	Section 5.4
miscellaneous/sample_imaging/[sample_tube]/ [sample_tube]_incidental_images.csv	Summary of all images acquired of each sample tube's location (both before and after tube drop) that were not acquired as planned documentation.	Table_Delimited	Section 5.5
miscellaneous/sample_mesh_files/ [sample_tube]_mesh_files.csv	Summary of all mesh files known to contain the location of each sample tube in each mesh file's footprint.	Table_Delimited	Section 5.6
miscellaneous/sample_metadata/ sample_tube_event_sols.csv	Summary of the key planning events for all sample tubes and the sols on which each occurred.	Table_Delimited	Section 5.7
miscellaneous/sample_metadata/ sample_tube_identifiers.csv	Listing of all identifiers for each sample tube.	Table_Delimited	Section 5.8
miscellaneous/sample_metadata/ sample_tube_locations.csv	Listing of rover locations during tube drop events and final sample tube orientations on the surface.	Table_Delimited	Section 5.9
miscellaneous/sample_metadata/ sample_tube_targets.csv	Listing of targets used during tactical or strategic operations associated with each sample tube.	Table_Delimited	Section 5.10

Table 6: Miscellaneous collection product listing

5.1. Campaign Sols

The Campaign Sols CSV gives the start and end sols for all rover campaigns involved in scouting the Three Forks Depot location and constructing the depot.

5.2. Depot Mosaics

The Depot Mosaics products are a set of three related products that summarize available depot-wide mosaics of the Three Forks Depot. The included mosaics were selected to provide the highest-resolution images of the Three Forks Depot available. There are other mosaics available but not listed here, such as:

- Lower-resolution mosaics acquired outside the Three Forks Depot (e.g. end-of-drive mosaics acquired for tactical planning during the Depot Reconnaissance campaigns)
- Mosaics acquired to document individual sample tubes, instead of the depot as a whole (these are included in the Documentation Image products, Section 5.4)

5.2.1. Depot Mosaics CSV

The Depot Mosaics CSV product lists all available mosaics, organized by instrument (EDLCAM [9], Navcam [9], Mastcam-Z [7], or WATSON [8]) and sol on which the mosaic was acquired. Also provided are the Site and Drive indices (Section 1.2.1), the LIDs (if any) of mosaic products in the PDS, the name of the rover campaign during which the mosaic was acquired, and a brief description of the mosaic.

For the two stereo-capable instruments (Navcam and Mastcam-Z), the "Mosaic LID 1" field refers to a mosaic product created using single images acquired by the left eye and the "Mosaic LID 2" field refers to a mosaic product created using single images acquired by the right eye. If either is not provided, no mosaic product was created for the corresponding eye.

As WATSON is a monocular instrument, only a single LID is provided, referring to a mosaic product created using all images acquired by the camera.

For EDLCAM, no mosaic products have been created, due to the large image dimensions required to combine all frames of a sidewalk movie into a single image. In addition, the Drive Index is considered meaningless, as all frames of a sidewalk movie were acquired at a different Drive Index.

5.2.2. Depot Mosaic Sequences

The Depot Mosaic Sequences CSV product lists the sequence IDs of the various commands used to acquire each of the EDLCAM, Mastcam-Z, and WATSON mosaics. These are intended to help identify the relevant single-frame products associated with each mosaic product. These are included in a separate product from the Depot Mosaics CSV because many of the mosaics were acquired over multiple sequences.

Sequence IDs for Navcam mosaics are not included in this product primarily because Navcam mosaics typically reuse sequences. As such, sequence IDs are not a recommended way to identify relevant single-frame products associated with Navcam mosaics. The Site and Drive Indices (Section 1.2.1) are typically preferred to identify relevant single-frame Navcam products, although PDS4 labels for Navcam mosaics also normally include a list of the single-frame products that were used to create each mosaic.

5.2.3. EDLCAM Sidewalk Frames

The EDLCAM Sidewalk Frames CSV lists the single-frame image products acquired as part of all EDLCAM sidewalk mosaics listed in the Depot Mosaics CSV.

5.3. Orbital Map

The Orbital Map is a clipped version of a larger orbital map showing the vicinity of Perseverance's traverse, archived as part of the Mars 2020 PLACES bundle [13]. The clipped Orbital Map has a black line drawn on it,

showing the traverse path of the rover during the Depot Creation campaign. A browse version of this product is included in the Browse collection.

5.4. Documentation Images

The Documentation Images CSVs list all images acquired as planned documentation images for each individual sample tube. The nominal set of images acquired for all sample tubes is as follows:

- CacheCam [9] images of each sample tube prior to drop
- WATSON [8] images of a subset of sample tubes in the Sealing Station prior to drop (these images are indicated by a comment in the Notes field)
- WATSON [8] images of each sample tube on the ground after tube drop
- Front HazCam [9] images of each sample tube on the ground after a short drive backwards
- Navcam [9] images of each sample tube on the ground after a short drive backwards
- Mastcam-Z [7] images of most sample tubes on the ground. For the sample tube M2020-00586-18 WB3/Amalik Witness, no standalone high-resolution Mastcam-Z documentation images were acquired. Instead, the high-resolution Mastcam-Z mosaic acquired on sol 693 provided similar quality coverage while also documenting the rest of the completed Three Forks Depot.

For each image product, the Documentation Images CSV provides the Sol, Site, Drive, Instrument, and LID. For most image products, an approximate Sample and Line coordinate of the sample tube in the frame is included. These are omitted for CacheCam, WATSON images of the sealing station, and some WATSON images of the ground (which were partially intended to confirm that the sample tubes were not underneath the rover's wheels, so they imaged the wheels even if no sample tube was present). For some image products, an associated mosaic is provided in the Mosaic LID field.

5.5. Incidental Images

The Incidental Images CSVs list all known images of sample tube locations (both before and after tube drop events) that were not acquired as planned documentation for the specific sample tube, along with the coordinates of the sample tube in each image. Individual images may occur in multiple different Incidental Images products if multiple sample tubes were in the field of view simultaneously.

5.6. Mesh Files

Mesh Files CSVs list the known 3D mesh products generated from Navcam and HazCam data that include each sample tube within the mesh footprint. Along with the instrument and LID of each mesh product, the intent is given, which has one of three possible values:

- Documentation: these mesh products were generated from post-drop Navcam and Front HazCam images acquired as planned documentation of each sample tube
- Pre-Drop: these mesh products were generated from pre-drop Navcam images that were used to plan the tube drop
- Incidental: all other mesh products

Documentation and Pre-Drop mesh products are expected to have the highest quality data of all mesh products available for each sample tube.

5.7. Event Sols

The Event Sols CSV summarizes the sols on which various key events for each sample tube occurred. These include the Bump Sol, on which the rover drove to the final drop location, the Drop Sol, on which the tube drop actually occurred, and all of the planned documentation imaging discussed in Section 5.4.

5.8. Sample Tube Identifiers

The Sample Tube Identifiers CSV summarizes relevant identifying information for each sample tube. These include the formal designation, informal name (and any alternates), unique identifiers for the drop zone and the sample tube, and serial numbers for all parts of the sealed tube.

5.9. Sample Tube Locations

The Sample Tube Locations CSV summarizes available location information for each sample tube. These include the Site and Drive indices of the rover during drop events and the rover's latitude, longitude, and elevation during drop events. For more details on these latitude, longitude, and elevation coordinates, see [12].

The Sample Tube Locations CSV also records the azimuth of the sample tube on the ground after tube drop, measured as the angle clockwise from the true north vector to a vector drawn from the seal end of the tube to the glove end of the tube.

5.10. Sample Tube Targets

The Sample Tube Targets CSV summarizes various strategic and tactical target names used during planning for each sample tube. These include:

- Drop Zone – Strategic: the drop zone target, defined strategically (for long-term planning purposes)
- Drop Zone – Tactical: the drop zone target, defined tactically (typically immediately prior to driving to the drop location, and used to plan the drive as precisely as possible)
- Drop Zone – End of Drive: the drop zone target, defined after arrival (typically used to validate the drive to the drop zone prior to dropping each tube)
- Drop Location – Glove: a target identifying the glove end of the sample tube post-drop
- Drop Location – Seal: a target identifying the seal end of the sample tube post-drop
- Imaging Target: a target used to plan the post-drop documentation imaging discussed in Section 5.4

6. Appendix: Terms and Acronyms

Term	Definition
ACA	The Adaptive Caching Assembly within the SCS [6]. The ACA is a collection of subsystems within the rover that manages sample handing and caching processes.
DEM	Digital Elevation Model
Drive	The Drive Index is incremented whenever the rover moves its wheels, such as during a drive. The combination of (Site, Drive) indices is frequently used to track the rover's location on the surface. See [12] for more details.
EE	End Effector attached to the end of the SHA [6]. The EE physically grips and manipulates sample tubes as they move through the ACA.
LID	PDS Logical Identifier associated with all versions of a bundle, collection or product [4]. Products in the Three Forks Depot Archive often use LIDs to refer to other products in the PDS while providing additional context.
LMST	Local Mean Solar Time. LMST is a timekeeping standard used during mission operations that divides each sol into 24 hours, further divided into minutes and seconds (each of which is approximately 2.75% longer than the corresponding unit on Earth). LMST times are typically represented as SOL-nnnnMhh:mm:ss.sss SOL-0653M13:38:22.157 where "nnnn" refers to the sol number, "hh" to the hour, "mm" to the minute, and "ss.sss" to the second.
M20 M2020	The Mars 2020 Perseverance rover [5]
MSR	The Mars Sample Return Campaign [5]
RZS	Product code for 12-bit zenith-scaled radiance products ([11], section 17). Within this User Guide, RZS is sometimes used as a shorthand to identify orthorectified mosaic products containing 12-bit zenith-scaled radiance data.
SCLK	Spacecraft clock count. The Perseverance rover uses a spacecraft clock that estimates the number of ephemeris seconds past the J2000 epoch (roughly noon UTC on January 1, 2000) as a primary timekeeping method.
SCS	The Sampling and Caching Subsystem on board the Perseverance rover [6]. The SCS consists of all elements of the rover that are involved in sample acquisition and processing.
Sequence ID	A nine-character string used to identify a set of commands used by the rover. Typically, the first four characters identify the instrument or subsystem for which the set of commands is designed, with the remaining five characters having instrument-specific meanings. Many image products include the sequence ID in the product names ([11]), which can often be used to help identify related products.
Site	The Site Index is used to refer to a specific coordinate frame on the surface of Mars. It is periodically incremented throughout the rover's traverse to create a new reference frame. See [12] for more details.

Term	Definition
SHA	The Sample Handling Assembly within the ACA [6]. The sample handling assembly manipulates sample tubes within the ACA.
Sol	A Martian solar day, given a different name to help distinguish it from a terrestrial solar day
STSA	The Sample Tube Storage Assembly within the ACA [6]. Most of Perseverance's sample tubes are stored within the STSA while they are not actively involved in sample acquisition or drop events.

Table 7: Definitions of terms and acronyms used within this User Guide