TBW/ DWPD/Endurance

All these 3 points leads to our main and final concern of a drive, the lifetime.
During our operation with the disk, the factor that affect the lifespan is how many GB data will be written in(or how many times will the disk be written fully, more specifically the NAND flash on board).
So 500GB written in per month will lead to different lifetime from 100GB written in.

X9 Lifespan (Endurance)

Endurance is related to follow parameters:

P/E Cycle (NAND Endurance):
NAND flash we used for 640GB X9 is MLC with P/E cycle of 3,000.

Disk Capacity:
640GB

WA (Write Amplification):
Based on X9 Series Controller:
WAI_A = 1.05 (Good Condition) WAI_B = 1.3(Bad Condition)

$$\textit{Write Amplification Index} = \frac{\textit{Total Data Written to NAND}}{\textit{Total Data Written by HOST}}$$

This formula explains how we could work our WA Index. Controller vendor need to have plenty tests for data accumulation before they release this index.

Data GB written-in per day/week/year:
Given your content added-up condition, we use assumed value as 200GB per week.

$$\text{Lifespan} = \frac{\text{NAND P/E Cycle} * \text{Disk Capacity}}{\text{WAI} * \text{DATA GB Written-In per Week} * \text{52Weeks/Year}}$$

Based above parameters, we could work out the lifespan of X9 640GB MLC is between **57 ~ 71 Years**, if 200GB written-in per week, way longer than 10 years' lifespan anticipation.

$$Drive\ Writes\ Per\ Day\ (DWPD) = \frac{Endurance * (1 + OP)}{Days\ Per\ Life * WA}$$

Regarding your question on DWPD, of course different GB written in results in both different Endurance and DWPD.

From above calculation of DWPD and Endurance, we know that OP is a Important factor.
With X9 solution, please be kindly note that we will be able to set OP higher by firmware, for applications in need of high reliability and longer lifespan

OP (Over-provisioning) :

Extended OP will help to expand the disk lifespan. Also with high OP the performance will be more stable when whole disk is written fully.

Generally our capacity options and OP for X9 Series are as below.

Capacity	LBA Counts(512Byte)	Over-provision (%)
32	62,533,296	6.818127632
64	125,045,424	6.833899021
80	156,301,488	6.837053299
128	250,069,680	6.841784716
160	312,581,808	6.843361855
256	500,118,192	6.845727563
320	625,142,448	6.846516132
480	937,703,088	6.847567558
512	1,000,215,216	6.847698987
640	1,250,263,728	6.848093271

However for clients within Server or Enterprise segment, who pay more attentio n to disk lifespan and the performance when disk is fully written, we could buil d the drive with Firmware version that allows OP to be extended to **27%**, to ex tend the lifespan furthest.

X9 Series Wear Leveling Basic concept

-Wear leveling algorithm arranges a data to distribute more evenly across the total flash array and finally intent to extend its expected life time ,But all blocks was made used evenly and flat wear led to increase the overhead of block erase and will be a reason of decreasing the total endurance

-The main goal of wear leveling is not making all erase count to the same value but prolonging to lifetime of SSD

X9 supports 2 types of wear leveling-Dynamic Wear Leveling

1. **Dynamic Wear Leveling**

•A method of pooling the available blocks that are free of data and selecting the block with the lowest erase count for next write

•Improves device life over no wear leveling at all

•Easier to implement than static wear leveling

•No impact on device performance

2. **Static Wear Leveling**

•All good blocks to evenly distribute wear, providing effective wear leveling and thereby extending the life of the device

•Maximizes device life and most robust wear leveling methods

•But requires more controller overhead and manages write operations

•More complicated to implement than dynamic wear leveling