Preserving DRUGS: Their Effects On You, an Apple II program by Marshware

Preservation work performed and documented by Matthew D'Asaro, 4/2022

I found this title on eBay, previously unpreserved in the Apple II community, with an asking price of \$200. This seemed high to me, especially once I looked closely at the auction images and realized that someone had applied Scotch tape directly to the media! After pointing this out to the seller and explaining to him that this meant that the data on the disk was likely lost, he agreed to accept a \$50 offer and the disk was soon in the mail to me.



Figure 1: Left: Front cover of software title from eBay auction; Right: Auction photo showing tape on Disk

After I received the software, I inspected it carefully, and indeed, the disk did have scotch tape on the media surface. This tape was very old and well adhered.



Figure 2: Left: Disk as received with tape on media surface; Right: Closeup of tape on media

I picked at the tape a bit (not on the media but on the disk jacket) and confirmed that it was old and hard as a rock. Since I know that isopropyl alcohol is generally safe on disks, and it will (slowly) dissolve tape adhesive, I decided to try that. I liberally applied the alcohol to the tape and then ever-so-gently tried to peel it, a tiny bit at a time. Unfortunately, the result was that the celluloid backing on the tape peeled away and left the adhesive layer on the disk. It was relatively easy to peel this adhesive layer off of the jacket, but it was really stuck to the media surface.



Figure 3: Adhesive removed from jacket but still adhered to media surface

Left with no other choice, I continued to keep the media wet with alcohol and hoped it would dissolve the adhesive. Unfortunately, the adhesive got gooey but did not really dissolve - it was really stuck to the disk surface. Finally, I was forced to use an alcohol wetted Q-Tip to dab very carefully at the adhesive and try to remove it one layer at a time.



Figure 4: Removing stuck adhesive from media surface with isopropyl alcohol and Q-Tip.

Using this technique, most of the adhesive residue was relatively easily removed, but near the edges of the tape, it was rock hard and despite my best efforts, I was not able to remove it all without a little bit of media damage. I feel terrible about this, but am not sure what I should / could have done differently. If you have ever tried to remove 40-year-old scotch tape, that stuff is tenacious. Held up to a light, I can see that a little bit of the oxide layer has come off with the adhesive at the damaged locations.



Figure 5: Media damage from removing adhesive

Despite the damage, I used my applesauce system to do a flux image of the disk three times, twice with my Apple 5.25 drive and once with my Disk II. The very first image taken seems to be the best with additional surface damage occurring on subsequent imaging attempts as I see more damage on Track 12 and 13. This first and best image attempt is in the file called "DRUGS- Their Effects On You - Disk 1, Side A.a2r". Because of the copy-protection used, the disk analyzer in applesauce was not able to recognize the file system or the checksum format for the sectors, so it was of only limited utility. However, it was able to identify damage on tracks 12 and 13. The rest of this document describes my attempt to recover data from this file.

Before jumping in, a quick note on terminology. Data on a floppy disk cannot be stored in the same format it is stored in memory. This is because on a floppy disk long runs of zeros or long runs of ones can't be stored directly – think of it a bit like sending data through a transformer or capacitor – DC (constant) voltage can't pass through. To get around this, Steve Wozniak invented a clever mechanism where a sequence of 8-bit bytes in memory would be written as a sequence of 5-bit "nibbles" on the disk. Later this was improved to be a 6-bit "nibble". In this document "nibble" refers exclusively to this encoded data.

Repairing Track 12

The damage in track 12 was overall much easier to fix than that in track 13 because the data that was damaged (which turned out to be part of an image) contained a lot of repetition, so by searching the entire disk for strings of nibbles identical to those found before and after the damaged area, the correct sequence of fluxes could be identified to fix the damaged area. Figure 6 shows track 12 before any repairs, with the damage highlighted.



Figure 6: Track 12 in the disk analyzer with the damaged section highlighted.

By searching the entire disk for the stream of nibbles immediately before the damaged area starts (97 BB AE 9B B2), it becomes clear that the next damaged nibble, which was read as FB9,

should most likely actually be a BD nibble as it is in every other occurrence of the pattern before the damage. See Figure 7 below.

	DRUGS- Their Effects On You - Disk 1, Side A - Repair attempt 4.a2r
197 31.75%-188 31.5%-1AE 31.5%-198 32.5%-182/9 33.6%-186/9 A A A A A A A A A A A A A A A A A A A	34450-1629 34450-198 31350-196 31350-196 31450-196 31350-196 31350-198 31350-196 31450-196 31450-196 31450-196
1994 197 31250-185 31250-1AE 31.255-198 32.525-182/9 33.625-196/9 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
Cack hisk to select. Use 4-4 to houge hisk. Shift 4 4-4 to add shift	
III ③ Show Track As Nibble Stream ③	NIBELS BITS FLUXES DUMATION EXECODING 1
B5 B5 97 9B 9A 96 9E A6 9F 97 B9 B7 A6 B9 B6 97 96 9A 96 97 9B B4 9B 9B 96 CF 97 CE A6 D9 D7	7 97 96 96 AE CD A6 D7 ED DD D6 96 96 96 9A DC 9E DD CD AE 9F 9D 97 9A B5 B7 96 <mark>B7 B6 BF 9F</mark> AA F3 FC F5
96 FF FE AB BA AA AA FE EE 9F AA EB F3 FC FF FF FF FF FF FF D5 AA AD FF CF CF D3 F6 DA FB BA	A AB AE A7 AB 9F AF 9F A6 AE AD 9F AB AE AE 9B A6 AB B2 9A 9B 9B A7 9B AB 9D A7 B3 A7 A6 A7 A7 AE B2 B2 97 97 97 97 B2 AB AB B2 9A 9F 9E AE AD
9F AE A6 9D 9E 9F AD A7 AE B2 9A 9A 97 AB AC 9E 9F 9F 9E AE B3 B2 AF A6 9D B3 AE 9E 9B 97 AD	D F6 DE B3 CF AE AF 96 AF 96 B6 CD 9B 96 9A 9A 9F 9E 9D 9F 97 B2 A7 A6 97 96 D3 CF 9A 9B 9B D3 CD B6 B5 97 BD BD AE CD B5 97 97 B5 B5 BE BE
96 96 D3 CF CE CD CB CB D3 CD AF B2 9A CB D3 97 AD BC AE BE 9B CE B4 96 D3 CF 9A 9B 96 CB 96	6 9D CD B3 AE 9A B6 BC AD 96 B3 96 CB BB AF 9B 96 D3 BE BD CF 9A B6 A7 BC B2 B5 AE B6 BC BC B2 96 D3 BE A7 B2 9B AF CF AE B3 9A B3 9F 9D AF CF
B3 D3 BE AB B3 9B B4 B6 9F CB B4 B6 BE A6 BD A6 D3 B3 B2 9F A6 B3 B3 A6 A6 96 B3 A7 A7 B3 A6	6 A6 B3 B3 A6 9F B2 AF 9E A6 B3 B2 9F A6 96 96 96 96 96 97 CF 9B 9B 9F BE 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	6 96 96 96 96 96 96 96 96 96 96 96 96 96
BA AA AB FE EF 9F AA EB F3 FC FF FF FF FF FF FF FF DS AA AD FF CF CA FA F9 D3 FF FB F5 BD B5 E7	7 EB CD BE D7 DC BA BB DB D9 BE B6 EA D9 CE CD D6 EC B4 CD B7 EB E5 D9 DB CF FB DA F5 B9 BA CE SE EA 77 F5 A7 DE A7 BC DA 82 F6 F5 EF 96 B4 D6
B4 F3 DA 9A AC FD DF EC BD B3 FA E9 AB B3 F5 9D AB EE BA AF CF FC B2 97 FE AF FE B5 B9 A6 96	6 96 96 D3 D3 BA B9 CF D3 97 B9 AC AC AC B9 D7 D6 FF FF D6 DB FB FF F6 F5 D7 DB FB FF 96 96 BA B9 CF D3 97 B9 AC AC AC AC B9 97 96 96 D3 D3
B3 D3 B3 B3 97 BB AE 9B B2 FB CB 9E 9C B4 B4 B6 9E 9D D5 CE FD E5 EE D6 AC AC AC B9 D7 D6 FF	F FF D6 D8 F8 FF FD FC D7 D8 DC D7 96 96 97 96 96 97 97 96 96 96 96 96 96 97 97 96 96 97 97 98 9A 96 96 97 97 97 96 96 97 97 96 96 96 96 96 96 96
D7 D6 D7 D7 D6 D8 F8 FE D7 E9 FC ED 97 EA B2 98 97 D7 FE FF D6 D6 E6 E5 DA D6 FF FF F6 F6 E6	D ED F4 F4 ED ED D6 E6 E5 D9 D6 D7 97 D6 A6 CF BD D9 FD FE E8 EC FF FF EC EC FF FF EC EC FF FF EC EC FF FF EC EC FF FF E7 D9 98 F3
F3 D7 D6 BE BE 96 D3 CF B3 B2 AF AF D3 CD 9E 9F 9B CB 96 A7 BB CF CF BA AD B2 A7 CF D3 CF CC	D CE D3 D3 D3 CD 98 96 98 CE 9F 82 8F CD 82 8E CB AF 82 D3 96 9F AA F3 FC FF
9F AA EB F3 FC FF FF FF FF FF FF FF D5 AA AD FF CF C9 D2	6 A6 F6 A6 A6 F5 A5
A5 A	5 45 45 45 45 45 47 13 96 96 9F 9F 9F 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	
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AC AC AC B9 97 96 96 D3 D3 D3 D3 B3 B3 97 BB AE 98 B2 BD B2 D3 D3 96 96 96 D3 D3 BA B9	• CF D3 97

Figure 7: Searching for the stream of nibbles before the damaged area and finding that the first damaged nibble (FB9) should actually be BD.

To change the FB9 nibble to BD, only one flux needs to be moved in the flux editor. When this is done, the nibble stream cleans up a lot and appears as shown in Figure 8 below.

• • •	DRUGS- Their Effects On 1	You - Disk 1, Side A - Repair attempt 4.a2r	
EXT 197 31,750/x1 88 31.300/x1 AE 31.125/x1 98 	32.125(s) B2 31.300(s) BD 31.375(s) B2 31.250(s) D3	31,375pr 03 31,375pr 96 31,305pr 96 31,375pr 96	31.125ys D3 31.759ys D3 31.875ys BA 31.125ys B9
PNAL 31.750ps BB 31.500ps AE 31.125ps J 197	32.125 ja 82 31.500 ja 80 31.375 ja 82 31.230 ja 03	31,375pn 03 31,250pn 96 31,500pn 96 31,375pn 96	31.125ja 03 31.759ja 03 31.875ja 6A 31.125ja 89
	Click flux to select. Use +++ to hudge flux. Shift + +++ to add time before or after flux. Option + +++ to	o subtract time. DELETE to remove hux. Shirt-click to add new hux. RETURN to save changes. ESC to n	event changes.
Atta Show Track As Nibble Stream		NIBBL 5	IS BITS FLUXES DUBATION ENCODING _L
B5 B5 97 9B 9A 96 9E A6 9F 97 B9 B7 A6 B9 B6 97 96	3 9A 96 97 9B B4 9B 9B 96 CF 97 CE A6 D9 D7 97 96 96 AE CD A6 D7	ED DD D6 96 96 96 9A DC 9E DD CD AE 9F 9D 97 9A B5 B7 96 B7 B	5 BF 9F AA F3 FC FF
96 FF FE AB BA AA AA FE EE 9F AA EB F3 FC FF FF FF	FF FF FF D5 AA AD FF CF CF D3 F6 DA FB BA AB AE A7 AB 9F AF 9F	A6 AE AD 9F AB AE AE 9B A6 AB B2 9A 9B 9B A7 9B AB 9D A7 B3 A	7 A6 A7 A7 AE B2 B2 97 97 97 97 B2 AB AB B2 9A 9F 9E AE AD
9F AE A6 9D 9E 9F AD A7 AE B2 9A 9A 97 AB AC 9E 9F	9 9F 9E AE B3 B2 AF A6 9D B3 AE 9E 9B 97 AD F6 DE B3 CF AE AF 96	AF 96 B6 CD 98 96 9A 9A 9F 9E 9D 9F 97 B2 A7 A6 97 96 D3 CF 9	A 9B 9B 9B D3 CD B6 B5 97 BD BD AE CD B5 97 97 B5 B5 BE BE
96 96 D3 CF CE CD CB CB D3 CD AF B2 9A CB D3 97 AD	BC AE BE 9B CE B4 96 D3 CF 9A 9B 96 CB 96 9D CD B3 AE 9A B6 BC	AD 96 B3 96 CB BB AF 9B 96 D3 BE BD CF 9A B6 A7 BC B2 B5 AE B	5 BC BC B2 96 D3 BE A7 B2 9B AF CF AE B3 9A B3 9F 9D AF CF
B3 D3 BE AB B3 9B B4 B6 9F CB B4 B6 BE A6 BD A6 D3	5 B3 B2 9F A6 B3 B3 A6 A6 96 B3 A7 A7 B3 A6 A6 B3 B3 A6 9F B2 AF	9E A6 B3 B2 9F A6 96 96 96 96 96 97 CF 9B 9B 9F BE 96 96 96 9	5 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	3 96 96 96 96 96 96 96 96 96 96 96 96 96	96 96 96 96 96 96 96 96 96 96 96 96 96 9	B FC FF DS AA 96 FF FE AB
BA AA AB FE EF 9F AA EB F3 FC FF FF FF FF FF FF D5	AA AD FF CF CA FA F9 D3 FF FB F5 BD B5 E7 EB CD BE D7 DC BA BB	DB D9 BE B6 EA D9 CE CD D6 EC B4 CD B7 EB E5 D9 DB CF FB DA F	5 B9 BA DC E5 EE A7 F5 A7 DE A7 BC DA B2 F6 F5 EF 96 B4 D6
84 F3 DA 9A AC FD DF EC BD B3 FA E9 AB B3 F5 9D AB	3 EE BA AF CF FC B2 97 FE AF FE B5 B9 A6 96 96 96 D3 D3 BA B9 CF	D3 97 B9 AC AC AC AC B9 D7 D6 FF FF D6 DB FB FF F6 F5 D7 DB FF	8 FF 96 96 BA B9 CF D3 97 B9 AC AC AC AC B9 97 96 96 D3 D3
B3 D3 B3 B3 97 BB AE 9B B2 BD B2 D3 D3 96 96 96 D3	3 D3 BA B9 CF D3 97 B9 AC AC AC AC B9 D7 D6 FF FF D6 DB FB FF FD	FC D7 DB DC D7 96 96 97 96 96 97 97 96 96 96 96 96 96 97 96 9	5 97 97 97 9B 9A 96 96 97 97 97 96 96 97 97 96 96 96 96 96 96
96 D7 D6 D7 D7 D6 D8 F8 FE D7 E9 FC ED 97 EA B2 98	3 97 D7 FE FF D6 D6 E6 E5 DA D6 FF FF F6 F6 ED ED F4 F4 ED ED D6	E6 E5 D9 D6 D7 97 D6 A6 CF BD D9 FD FE EB EC FF FF EC EC FF FI	F EC EC FF FF EC EC FF FF EC EC FF FE D7 D9 9B
F3 F3 D7 D6 BE BE 96 D3 CF B3 B2 AF AF D3 CD 9E 9F	F 9B CB 96 A7 BB CF CF BA AD B2 A7 CF D3 CF CD CF D3 D3 D3 CD 9B	96 98 CE 9F B2 BF CD B2 BE CB AF B2 D3 96 9F AA F3 FC FF FF	F FF FF FF FF FF FF FF FF D5 AA 96 FF FF AB BA AB AA FF
FE 9F AA FR F3 FC FF FF FF FF FF FF D5 AA AD FF CF	F (9 D2	10 10 10 10 10 10 10 10 10 10 10 10 10 1	10 10 10 10 10 10 10 10 10 10 10 10 10 1
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Figure 8: Damaged section on track 12 after a single flux is moved to change the FB9 nibble to be BD.

With this correction made, I initially thought that the track was fixed. However, after getting track 13 done, passport was still reporting an error here. Looking more closely at the search

results shown in Figure 7, there is another error. In the damaged section the third D3 in the sequence 96 D3 D3 D3 D3 B3 has been replaced with a B3. We can be highly confident that this is an error because this sequence is repeated five times in other places on the disk and the damaged section is the only one that doesn't match this pattern. Again, only a single nibble had to be moved to make the correction. With this corrected, the final reconstruction of track 12 is shown below in Figure 9 with the corrected pattern highlighted. Note that other than the repetition, at this point in the project I had no way to confirm that this reconstruction was correct.

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9F	AE	A6 91	D 9E 1	9F AD	A7 AE E	2 9A 9	A 97	AB AC	9E 9F	9F 9	EAEB	3 B2 A	F A6 9	9D B3	AE 91	E 9B	97 AD	F6 D	E B3	CF A	E AF	96 A	F 96	B6 C0	9B	96 9A	9A 9F	9E 9	D 9F	97 B2	2 A7 /	6 97	96 D3	B CF S	9A 9B	9B 9B	D3 C	а ве	B5 97	BD B	D AE	CD B5	97 97	B5 B3	5 BE B	ε
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B3	D3	BE A	B B3 1	9B B4 I	36 9F (B B4 E	6 BE	A6 BD	A6 D3	B3 B3	2 9F A	6 B3 E	I3 A6 /	AG 96	B3 A3	7 A7	B3 A6	A6 B	3 B3	A6 9	F B2	AF 9	E A6	B3 B2	2 9F	AG 96	96 96	5 96 9	6 97	CF 98	3 9B 9	F BE	96 96	5 96 9	96 96	96 96	96 9	ő 96	96 96	96 9	696	96 96	96 96	96 9	5969	6
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D3	D3	B3 B3	3 97	BB AE 9	9B B2 B	ID B2 C	03 D3	96 96	96 D3	D3 B	A B9 C	F D3 9	7 B9 /	AC AC	AC A	C B9	D7 D6	FF F	F D6	DB F	B FF	FD F	C D7	DB DO	C D7	96 96	97 96	5 96 9	7 97	96 96	5 96 9	6 96	96 97	7 96 9	96 97	97 97	9B 9	A 96	96 97	97 9	796	96 97	97 96	96 9	5 96 9	6
96	D7	D6 D7	7 D7 I	D6 DB I	FB FE C	07 E9 F	C ED	97 EA	B2 9B	97 D	7 FE F	F D6 D	6 E6 E	E5 DA	D6 FI	FFF	F6 F6	ED E	D F4	F4 E	D ED	D6 E	6 E5	D9 D6	6 D7	97 D6	A6 CF	BDC	9 FD	FE E	BECH	FFF	EC E	FFF	FF EC	EC FF	FF E	C EC	FF FF	EC E	C FF	FF EC	EC FF	FE D	7 D9 9	6
F3	F3	D7 D	6 BE	BE 96 I	03 CF E	13 B2 #	FAF	D3 CD	9E 9F	9B CI	B 96 A	7 BB (FCFE	BA AD	B2 A3	7 CF	D3 CF	CD C	E D3	D3 D	3 CD	9B 9	6 9B	CE 9	F B2	BF CD	B2 BE	E CB A	IF B2	D3 96	5 9F /	A F3	FC FI	F FF 1	FF FF 10 10	FF FF 10 10	FF FI 10 1	FF	FF FF 10 10	FF D	5 AA	96 FF	FE AB	BA A	B AA F	F
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A5	A5	A5 A	5 A5	A5 A5 /	A5 A5 /	5 A5 A	5 A5	A5 A5	A5 A5	A5 A	5 A5 A	5 A5 A	5 A5 /	A5 A5	A5 A5	5 A5	A5 A5	A5 A	5 A5	A5 A	5 A5	A7 D	3 96	96 98	E 9E	9B 96	96 96	5 96 9	6 96	96 96	5 96 9	6 96	96 96	5 96 9	96 96	96 96	96 9	ð 96	96 96	96 9	696	96 96	96 96	96 9	5 96 9	6
96	96	96 96	6 96 9	96 96 9	96 96 9	6 96 9	6 96	96 96	96 96	96 9	6969	6 96 9	6 96 9	96 96	96 96	5 96	96 96	96 9	6 96	96 9	6 96	96 9	6 96	96 96	5 96	96 96	96 96	5 96 9	6 96	96 96	5 96 9	6 96	96 96	5 96 9	96 96	96 96	96 9	δ 96	96 96	96 99	696	96 96	96 96	96 9	5 96 9	6
96	96	96 9	6 96 9	96 96 9	96 96 9	6 96 9	6 96	96 96	96 96	96 9	6969	6969	6 96 9	96 96	96 96	5 96	96 96	96 9	696	96 9	696	96 9	696	96 96	5 96	96 96	96 96	5 96 9	6 96	96 96	5 96 9	6 96	96 96	5 96 9	96 96	96 96	96 9	δ 96	96 96	96 9	696	96 96	96 96	96 9	5969	6
0.6 (7)	0	12.0	00 1	<u>A</u> 55	; ;		???	6.06			6.06.0	6 06 0	6 06 0	06 06	06.04	. 0.6	06.06	06.0	6 96	06.0	6 06	06.0	6 06	06.04	6.06	DE 06	06.06		EAA	E2 E/		C CC	CC C1		ce ce	EE_EE	CC C	d ne	** 06		C AD	Pro	AD EE	cc of	E AA E	D Meradata
Se	arch	Nibb	ie Strea	m		0	on 🛛	II Tracks		ᅌ for	Hex	0	7BBAE9	882									Fi	ind																					5 m	atches
17 A 17 A 17 A 17 A	ack \$ C AC ack \$ C AC ack \$ C AC ack \$ C AC ack \$ C AC	AC 1 AC 1 AC 1 AC 1 AC 1 AC 1 AC 1 AC 1	at Index B9 97 It Index B9 97 It Index B9 97 It Index B9 97 It Index B9 97	754 (802 7 96 96 4216 (\$10 7 96 96 4432 (\$11 7 96 96 1336 (\$00 7 96 96 2742 (\$0.) 7 96 96	F2) D3 D3 (78) D3 D3 (50) D3 D3 (538) D3 D3 (538) C3 D3 (538)	03 03 03 03 03 03 03 03 03 03	8 B3 6 8 B3 6 8 B3 6 8 B3 6 8 B3 6	13 97 13 97 13 97 13 97 13 97	BB AE BB AE BB AE BB AE	98 8 98 8 98 8 98 8 98 8	2 80 8 2 80 8 2 80 8 2 80 8	32 D3 32 D3 32 D3 32 D3 32 D3 32 D3	D3 96 D3 96 D3 96 D3 96 D3 96	96 9 96 9 96 9 96 9	96 D3 96 D3 96 D3 96 D3 96 D3	D3 B D3 B D3 B D3 B D3 B	A B9 A B9 A B9 A B9 A B9	CF D3 CF D3 CF D3 CF D3 CF D3	3 97 3 97 3 97 3 97 3 97																											

Figure 9: Damaged section on track 12 after a single flux is moved to change the erroneous B3 nibble to be D3. With this correction made, the damaged section is now repaired, although this repair cannot be validated yet.

Repairing Track 13

Track 13 was much harder to repair than track 12 because, first, the damage was a lot more extensive, and second, there was not a lot of repetition of the data around the damaged area from which I could determine the correct reconstruction. Figure 10 below shows track 13 in the disk analyzer with the damaged area highlighted.



Figure 10: Track 13 in the disk analyzer with the damaged section highlighted.

Searching for the sequence of nibbles immediately before or after the invalid 85 nibble did not yield any other matches elsewhere on the disk. After discovering this, I put aside trying to figure out the damaged "85" nibble and focused on the damage following it. Searching for the sequence EF DD D6 96 yielded five matches elsewhere on the disk and showed that the damaged 8E nibble should most likely be 96 as that is what it is in all the other places on the disk with that same sequence. See Figure 11.

Inclusion of the second sec	empt 4.a2r
1977 1979 - 31295m DO - 31595m DO - 31.375m SG - 30.375m SG - 32.255m S7.711 - 41.375m DG - 30.375m G4 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 - 1971 -	31.500p. EE / 9 31.335p. DA 31.250p. F 9 31.455p. AA / 9 34.875p. D4 31.500p. D3 / 9
nea 127 31750- 30 31350- 36 31370- 36 31370- 36 31270- 37 41250- 37711 41270- 36 31370- 64 31370- 64 11111111111111111111111111111111111	31.500/e [EE/9 35.570/e [DA 31.500/e [F9 31.630/e]AA/9 34.670/e [D4 31.500/e [D3/9
Cilck flux to select. Use +++ to nudge flux. Shift + ++ to add time before or after flux. Option + ++ to subtract time. DELETE to remove flux.	Shift-click to add new flux. RETURN to save changes. ESC to revert changes.
E 👫 C Show Track As Nibble Stream	NIBBLES BITS FLUXES DUBATION ENCODING
96 A6 96 B9 B7 9A B5 B7 9A 9A 96 A6 9A BA 9B B9 A6 96 9F 9D 96 B5 B9 9E 97 96 9E A6 97 96 B7 BA A6 97 9A B6 9B B4 9B 9A B5 B6 97 9B 96 9A	97 97 A6 98 B8 BA 9F B7 BA 9E 9B 97 B6 B9 97 9D 97 97 98 97 9E BA 9B 9F DC FF 97 DD DE 97 DB DC
9D DB F7 97 FF DD 97 CB D9 D7 97 96 96 9A DB DD 96 96 97 97 AE FF DA F7 EB DD D6 97 97 AE E9 ED CD 9F AA F3 FC FF FF FF FF FF FF FF FF FF	FF FF FF D5 AA 96 FF FE AB BB AF AA FB EF 9F AA EB F3 FC FF FF FF FF FF FF FF D5 AA AD FF CF C9 B9
A9 F3 A5 E5 E5 E5 E5 E5 E5 E5 E5 A5	A5 A
A5 A5 A5 A5 B8 E8 CF BA CB 97 BF CB B2 B2 CB D7 FA 96 96 96 96 96 96 96 96 96 96 96 96 96	96 96 96 96 96 96 96 96 96 96 96 96 96 9
96 96 96 96 96 96 96 96 96 96 96 96 96 9	96 96 96 96 96 96 96 96 96 96 96 96 96 9
96 96 96 96 96 96 96 96 96 96 96 96 96 9	96 96 96 96 96 96 96 96 96 96 96 96 96 9
96 96 96 96 96 96 96 96 96 96 96 96 96 9	AA 96 FF FE AB BB AF AB FB EE 9F AA EB F3 FC FF FF FF FF FF FF FF FF D5 AA AD FF CF CA EB FA FA F6 DD
CE AB FE FA AE F4 FE AF E7 DF EB B6 F6 B7 E7 EC AD B9 9A E6 B5 CD BD CF D9 AC 9D EB E7 DC F3 B7 E6 EE E6 BE E6 FF BB F2 B6 BE EF BF CB E9	B3 AD B7 A7 DE CF DA F2 AB EB DD D3 A6 9B F5 EA ED F3 B6 F6 F2 EE F2 DF B3 9A B5 F3 EF DB 9D FA
85 FF B9 EF DD D6 96 8E 97 D6 E4 F6 E DA F9 AA D4 D3 AD DD A6 97 B7 B4 9B 96 A6 97 9F 9A B5 B4 B4 B9 9F 97 9F BA B7 A6 B9 B7 96 A6 9E B5	B7 9A B5 B4 9B 9B 9B 97 97 96 B7 B7 9F 9D 9E B9 B4 B4 B9 9F 97 A6 97 BA B9 9E 9E 9F 97 9A B5 B7
9A B5 BA A6 97 9A B5 B9 9F 9F 9F 9F B6 B5 9A 97 97 9A B5 B6 97 9F 9F B7 B4 B4 B4 9B 96 9B B4 B7 A6 B9 B5 A6 9D 97 9A B6 9B B5 9E 96 9E 97 9A	9A 9B 96 9E BB B6 9B B5 BA A6 9B A6 BB B4 9D 9E B5 B7 97 9B 9B A6 BA B6 97 B7 BA 9D 9B 9B A6
B8 9B 9B 96 CF 97 CE A6 BF 97 D7 F7 9A D9 D7 97 96 96 9A D9 D6 96 96 96 AE B8 AD EA FA D3 97 CE FD F7 96 96 9A DC 9E DD CD B2 9D 9A 9F 9A	96 9B B7 B5 96 9E 9E 9A 9A 96 9A 9B 97 B5 B4 96 9B B7 B9 9E 9E 97 9F 9F BA B5 9E A6 96 B7 B4 9B
96 A6 97 9F 97 97 9A B5 B9 9E 9D 90 9E 9D 9B B7 B5 9E 9F 97 97 9F B9 A7 9F AA F3 FC FF	BB AE AE FA EB 9F AA EB F3 FC FF FF FF FF FF FF D5 AA AD FF CF CA BD 9D F7 9F DD DF DD 9F 93 BC
BA DA FE EE ED BB B6 B9 B6 D7 BB DA E6 FD FF CB B2 E6 DA 97 DB BF FA D6 BB BA AB D9 A7 D6 DD F3 BC B7 AC B8 E7 9B DC F4 B7 E6 DA AD DB DE	D6 E6 A7 E6 FC BB 9F AC AD D7 E7 FB CD BB 9B CE DF DE CF FD DA ED DC 96 E9 B2 F7 FB EB FD CD B2
97 9B 97 B5 B4 9B 9B 96 9A 97 9A B5 B6 9F B9 B5 A6 9A 9E 9A A6 9F A6 9D B5 B4 9B 9A B5 B6 97 96 9A 96 97 9B B4 9B B7 9B 9B 9E BB B4 96 9E	97 9E 9E 96 B9 B5 9A B7 B5 96 96 9E A6 9E BB B6 97 9F B7 B5 96 97 9E BA B7 A6 B9 B4 9B 96 96
97 A6 BA B4 9D 9F 97 9A 9E B9 BA 9F B7 B9 97 97 96 A6 A6 97 BA BA A6 98 9B 9F B9 B6 9A 96 9A A6 97 BC 9B 9F D9 D6 97 97 9A D9 D7 97 96 96	9A DA F9 97 FF DD 96 9A 9B 97 AE BD 9B EE D6 D3 97 CE FD F7 96 96 9A DC 9E DD BD AE 9D 96 9A B6
DE DE DE DA DE DE DA AT DA DE DE DT DT DA DA DA DA DA DA DA DE DE DE DE DA DE DA DE DA DE DT DA DE DA DE DE DE DA DE DA DE DE DA DE DE DA DE DE DA DE	BO BA OT AT DE AB DE AE DE DO AE DE OT OD DE DE DE AT DT DA DA DO DE DE DE AB DA AD DA DE
Search Nibble Stream 0 on All Tracks 0 for Hex 0 EFDDD696 Find	5 matches
Track 504.00 at Index 5530 (11564) 96 9A CE DE F7 9A D9 D6 97 97 AE B4 A7 D6 EF DD D6 96 96 97 9B DC 9E DD BF A8 9F 9D 9D 9D 9E BC	
77ack 505.00 at Index 90.4 (153.58)) 49.4 GE R.9.4 GE D.9.7 97.96 GE AF ED DB D7 <mark>FE DD DE 96</mark> .96 97 98 DC 95 DD BD A7 95 97 95 95 95 99	
Track \$13.00 at Index 4215 (\$1077)	
EE F2 DF 83 9A 85 F3 EF D8 9D FA 85 FF 89 <mark>EF DD D6 96</mark> 8E 97 D6 E4 F6 EE DA F9 AA D4 D3 AD DD A6	
Track \$18.00.41 (Hext 3220 (50750) 9A 9F 8B 98 9F D9 07 97 96 96 AE CF A6 07 EF DD D6 96 97 9B DC 9E DD BD A7 9E 97 9E 96 89	
Track \$22.00 at index 2172 (\$087C)	
96 9A CE DE F7 9A D9 D6 97 97 AE AF BA D6 <mark>EF DD D6 96</mark> 96 97 9B DC 9E DD BF AB 9F 9D 9D 9D 9E BC	

Figure 11: Searching for the stream of nibbles before the damaged "8E" nibble and finding that the damaged nibble should be 96.

To repair this section, I changed the 8E nibble to 96 by moving a single flux, then, again following the search results shown in Figure 11, I changed the 9711 nibble to 97 by moving one

flux and adding one more, and the following D6 nibble to 9B by adding one more flux. With these changes made, all the damage in track 13 except for the unknown "85" nibble appears to be corrected. See Figure 12 and compare with Figure 11.

•••	DRUGS- Their Effects On Ye	ou - Disk 1, Side A - Repair attempt 4.a2r	
Ебт ЕF 31.250µx DD 31.500µx D6 31.325µx 96 	30.375yn 96 32.250yn 97 31.750yn 98 31.000yn DC	31.375pe 9E 31.250pe DD 31.500pin CD 31.500pe	AF 31.375yn [9A 31.375yn]AG 31.375yn [AG 31.375yn]9A
Рики. EF 31.756,ик DD 31.500,ик D6 31.375µк 96 	30.375ys 96 32.226ys 97 31.726ys 98 31.000ys DC	31.375µs 9E 31.250µs DO 31.500µu CD 31.500µs D. D. D	AF 31.375µ1 9A 31.375µ1 A6 31.375µ1 A6 31.375µ1 9A
	Click flux to select. Use ←→ to nudge flux. Shift + ←→ to add time before or after flux. Option + ←→ to	subtract time. DELETE to remove flux. Shift-click to add new flux. RETURN to save changes. ESI	C to revert changes.
La		'	VIBBLES BITS FLUXES DURATION ENCODING
96 A6 96 B9 B7 9A B5 B7 9A 9A 96 A6 9A BA 9B B9 A6 96	5 9F 9D 96 B5 B9 9E 97 96 9E A6 97 96 B7 BA A6 97 9A B6 9B B4 9	B 9A B5 B6 97 9B 96 9A 97 97 A6 9B BB BA 9F B7 BA 9E 9B 9	7 B6 B9 97 9D 97 97 9B 97 9E BA 9B 9F DC FF 97 DD DE 97 DB DC
9D DB F7 97 FF DD 97 CB D9 D7 97 96 96 9A DB DD 96 94	6 97 97 AE FF DA F7 EB DD D6 97 97 AE E9 ED CD 9F AA F3 FC FF F	F FF FF FF FF FF FF FF FF FF D5 AA 96 FF FE AB BB AF A	A FB EF 9F AA EB F3 FC FF FF FF FF FF FF D5 AA AD FF CF C9 B9
A9 F3 A5 E5 E5 E5 E5 E6 A5 E5 A5 A5 A5 A5 A5 A5 A5 A5 A5	5 A5	IS A5	5 A5
A5 A5 A5 A5 BB EB CF BA CB 97 BF CB B2 B2 CB D7 FA 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96	6 96 96 96 96 96 96 96 96 96 96 96 96 96	6 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	5 96 96 96 96 96 96 96 96 96 96 96 96 96	16 96 96 96 96 96 96 96 96 96 96 96 96 96	6 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	5 96 96 96 96 96 96 96 96 96 96 96 96 96	16 96 96 96 96 96 96 96 96 96 96 96 96 96	6 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	5 96 96 96 96 96 96 96 96 96 <mark>96 96 96 97</mark> AA F3 FC FF FF FF FF FF	F FF FF FF FF FF FF D5 AA 96 FF FE AB BB AF AB FB EE 9F A	A EB F3 FC FF FF FF FF FF FF D5 AA AD FF CF CA EB FA FA F6 DD
CE AB FE FA AE F4 FE AF E7 DF EB B6 F6 B7 E7 EC AD B5	9 9A E6 B5 CD BD CF D9 AC 9D EB E7 DC F3 B7 E6 EE E6 BE E6 FF E	10 10 10 10 10 10 10 10 10 10 10 10 10 1	10 10 10 10 10 10 10 9 9 9 9 9 9 9 9 9 9
85 FF B9 EF DD D6 96 96 97 98 DC 9E DD CD AF 9A A6 A6	5 9A B5 BA A6 97 B7 B4 9B 96 A6 97 9F 9A B5 B4 B4 B9 9F 97 9F B	A B7 A6 B9 B7 96 A6 9E B5 B7 9A B5 B4 9B 9B 9B 97 97 96 B	7 B7 9F 9D 9E B9 B4 B4 B9 9F 97 A6 97 BA B9 9E 9E 9F 97 9A B5
B7 9A B5 BA A6 97 9A B5 B9 9F 9F 9F B6 B5 9A 97 97 9/	A B5 B6 97 9F 9F B7 B4 B4 B4 9B 96 9B B4 B7 A6 B9 B5 A6 9D 97 9	A B6 9B B5 9E 96 9E 97 9A 9A 9B 96 9E BB B6 9B B5 BA A6 9	B A6 BB B4 9D 9E B5 B7 97 9B 9B A6 BA B6 97 B7 BA 9D 9B 9B 9B
46 RR 9R 9R 96 CF 97 CF 46 RF 97 D7 F7 94 D9 D7 97 94	5 96 94 D9 D6 96 96 96 4F RR 4D F4 F4 D3 97 CF FD F7 96 96 94 0	0C 9F DD CD R2 9D 94 9F 94 96 9R R7 R5 96 9F 9F 94 94 96 9	A 9R 97 R5 R4 96 9R R7 R9 9F 9F 9F 9F 9F RA R5 9F 46 96 R7 R4
9R 96 46 97 9F 97 97 94 R5 R9 9F 9D 9D 9F 9D 9R R7 R	S OF OF OF OF OF A A OF AA F3 FC FF	F FF FF DS AA 96 FF FF AR RR AF AF FA FR 9F AA FR F3 FC F	E FE FE FE FE DS AA AD FE CE CA RD 9D F7 9F DD DE DD 9F 93
RC RA DA FE FE FD RR B6 R9 R6 D7 RR DA F6 FD FE CR R	10 10 10 10 10 10 10 10 10 10 10 10 10 1	R DC F4 B7 F6 D4 AD DB DE D6 F6 A7 F6 FC BB 9F AC AD D7 F	7 FR CD RR 9R CF DF DF CF FD DA FD DC 96 F9 R2 F7 FR FR FD CD
	E DO DE 37 DO DE TE DO DO DE DE ROS ES E, DO DO TO DE D, E DE E .	$\begin{array}{c} \mathbf{D} $	C OF AC OF DD DC OT DE OF D7 DE OC O7 OF DA D7 AC D0 D4 OD OC
05 07 46 04 00 05 07 04 05 00 07 07 04 05 00 07 07 07 07 07	5 5K 5E 5K KO 5F KO 50 55 54 56 5K 55 50 57 50 5K 50 57 56 57 56 57 56 57 56 57 56 57 56 57 56 57 57 56 56 56 57 57 57 56 56 56 56 56 56 56 56 56 56 56 56 56	0 07 90 90 90 90 07 07 06 06 04 90 90 90 90 90 90 07 09 07 07 08 00 07 07 06 06 04 00 07 07 06	E PD OP EE DE DO 37 JF FF D7 D3 30 37 3E DA D7 A0 D3 D4 30 30
90 97 A0 DA D4 90 97 97 9A 9E 09 DA 97 D7 D3 97 97 97	0 A0 A0 97 DA DA A0 90 90 97 09 00 9A 90 9A A0 97 DC 90 9F 09 0	0 97 97 98 09 07 97 96 90 98 08 F9 97 FF 00 96 98 95 97 8	
⊡ 13.00 ▲ 55 Ⅲ. ○ □ m			Processing complete.
Search Nibble Stream O on All Tracks O	for Hex C EFDDD696	Find	5 matches
Thate BAL 00 at Holes (1830) The ISA 05 9A.C. DE CF 3A.D.9 D6 37 97 AE BA A7 D6 EF D0 D Thate BAL 00 at Holes R04 (18308) 3A 5B 70 87 79 76 56 AE ED D8 D7 EF D0 D These BAL 00 at Holes R04 (18308) 3A 3B 71 85 78 65 AE ED D8 D7 FE D9 DA B7 D8 39 67 00 77 79 65 66 AE ED D8 D7 FE D9 EF 2D D0 These BAL 00 at Holes R04 (18308) 3A A8 D5 73 57 65 96 AE CF A8 D7 FE D0 D0 These BAL 00 AT HOLE 00 T6 T6 T6 T6 D0 D0 These BAL 00 AT HOLE 00 T6 77 67 97 97 96 96 AE CF A8 D7 FE D0 D0 These ST2 000 FM 877 (16072) 96 9A CE DE F7 9A D9 D6 97 97 97 97 9A AF BA D6 EF D0 D0	6 96 96 97 98 DC 9E DD BF AB 9F 9D 9D 9D 9E BC 6 96 96 97 98 DC 9E DD BC A7 9E 97 9E 9E 96 B9 6 96 96 97 98 DC 9E DD DD A7 9E 97 9E 9E 96 B9 6 96 96 97 98 DC 9E DD BD A7 9E 97 9E 9E 96 B9 6 96 96 97 98 DC 9E DD BF AB 9F 9D 90 9D 9E BC		

Figure 12: The damaged section of track 13 with all damage other than the damaged "85" nibble apparently corrected.

With these corrections made, the next thing I had to do was figure some way to determine what the correct nibble was to replace the "85". With no other copies of that sequence of nibbles found elsewhere on the disk, I had to get creative for this one. The biggest problem with understanding what kind of data was damaged in this section was that the disk is copy-protected so that applesauce can't read the filesystem. Attempting to verify it with Passport, however, indicated that it was a modified DOS 3.3 disk and Passport could even verify all tracks higher than the damaged track 13. Furthermore, when trying to run the program in an emulator it would fail with errors like "Error xx in line yy" which seemed to indicate that it was a DOS 3.3 BASIC program underneath the copy protection. Thus, I figured that if I could find some way of getting the damaged sector to pass its checksum, then Passport would likely to able to "crack" it far enough that I could read the files and maybe figure out how to correct the damage. Because the checksums on DOS 3.3 disks are (in the standard format anyway) only one nibble long, by changing a single nibble correctly, the checksum can always be made to pass. Since there are only 64 possible valid nibbles (see Figure 13) I set about trying them one-by-one in place of the damaged "85" nibble. To do this, I brought up another copy of the disk in another disk editor window and then searched this other copy for each possible nibble in the table so that I could see what that nibble looked like and modify the fluxes in the damaged "85" nibble to match it. Once I had the "85" nibble modified for the current attempt, I would export a .woz file and try verifying the new .woz in Passport in AppleWin. On the 28th attempt, the nibble "CB" worked, and track 13 verified in Passport successfully.

		"6 and	2"	
	WRITE	TRANSL	ATE TABLE	
00 = 96	10 =	B4	20 = D6	30 = E0
01 = 97	11 =	B5	21 = D7	31 = EE
02 = 9A	12 =	B6	22 = D9	32 = EF
03 = 9B	13 =	B7	23 = DA	33 = F2
04 = 9D	14 =	B9	24 = DB	$34 = F_{3}^{2}$
05 = 9E	15 =	BA	25 = DC	35 = F4
06 = 9F	16 =	BB	26 = DD	$36 = F_{2}^{4}$
07 = A6	17 =	BC	27 = DE	37 = F6
08 = A7	18 =	BD	28 = DF	38 = F7
09 = AB	19 =	BE	29 = E5	39 = F9
OA = AC	1A =	BF	2A = E6	3A = FA
OB = AD	1B =	CB	2B = E7	3B = FE
OC = AE	1C =	CD	2C = E9	3C = F(
OD = AF	1D =	CE	2D = EA	3D = F0
0E = B2	1E =	CF	2E = EB	3E = FE
0F = B3	1F =	D3	2F = EC	3F = Ff

AA D5 Reserved Bytes

Figure 13: Table of all 64 possible valid nibbles. (Image from https://www.bigmessowires.com/2015/08/27/apple-ii-copy-protection/)

At this point in the process, the damaged section of track 13 appeared as in Figure 14 in the disk editor. I was able to export it to a .woz which is preserved as "DRUGS- Their Effects On You - Disk 1, Side A - repair attempt 3.woz" and which would verify successfully in Passport and would boot and would mostly even work. However, attempting to play through the game quickly revealed that there were still errors. Selecting "2. Choose one topic" from the main menu, then selecting "3. Depressants" and playing through the first three screens, the first quiz (alcohol is not a stimulant in case you are wondering), and then another two screens would result in a crash as shown in Figure 15.

• • •	DRUGS- 1	Their Effects On You - Disk 1, Side A - Repair attempt 4.a2r	
есят EF 31,750,н DD 31,500,н D6 31,375,н 96 Л	38.375µx 96 32.250µx 97 31.750µx 98	31,000yn DC	21.500m AF 21.375m 9A 21.375m AG 31.375m AG 31.375m AG 1.1.375m A
ИМАL EF 31.3750µл DD 31.500µл D6 31.375µл 96 	30.375µ1 96 32.250µ1 97 31.750µ1 98	31.000ys DC 31.375ys 9E 31.250ys DD 31.300ys CD	2).500% [AF 3].575% [9A 3].575% [AG 3].575\% [AG 3].575
Ciick	flux to select. Use \leftrightarrow to nudge flux. Shift + \leftrightarrow to add time before or after	er flux. Option + \leftrightarrow to subtract time. DELETE to remove flux. Shift-click to add new flux. RETURN 1	save changes. ESC to revert changes.
A 북부 ④ Show Track As Nibble Stream 🗘			NIBBLES BITS FLUXES DURATION ENCODING
96 A6 96 B9 B7 9A B5 B7 9A 9A 96 A6 9A BA 9B B9 A6 96 9F	F 9D 96 B5 B9 9E 97 96 9E A6 97 96 B7 BA A6 97	7 9A B6 9B B4 9B 9A B5 B6 97 9B 96 9A 97 97 A6 9B BB BA 9F B	7 BA 9E 9B 97 B6 B9 97 9D 97 97 9B 97 9E BA 9B 9F DC FF 97 DD DE 97 DB DC
9D DB F7 97 FF DD 97 CB D9 D7 97 96 96 9A DB DD 96 96 97	7 97 AE FF DA F7 EB DD D6 97 97 AE E9 ED CD 9F	AA F3 FC FF	AB BB AF AA FB EF 9F AA EB F3 FC FF FF FF FF FF FF D5 AA AD FF CF C9 B9
A9 F3 A5 E5 E5 E5 E5 E6 A5 E5 A5	5 A5	5 A5	5 A5
A5 A5 A5 A5 BB EB CF BA CB 97 BF CB B2 B2 CB D7 FA 96 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	5 96 96 96 96 96 96 96 96 96 96 96 96 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	5 96 96 96 96 96 96 96 96 96 96 96 96 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96	5 96 96 96 96 96 96 96 96 96 96 96 96 96
96 96 96 96 96 96 96 96 96 96 96 96 96 9	5 96 96 96 96 96 96 96 96 <mark>96 96 96 9F</mark> AA F3 FC FF	FF DS AA 96 FF FE AB BB AF A	FB EE 9F AA EB F3 FC FF FF FF FF FF FF D5 AA AD FF CF CA EB FA FA F6 DD
CE AB FE FA AE F4 FE AF E7 DF EB B6 F6 B7 E7 EC AD B9 9/	A E6 B5 CD BD CF D9 AC 9D EB E7 DC F3 B7 E6 EE	E E6 BE E6 FF BB F2 B6 BE EF BF CB E9 B3 AD B7 A7 DE CF DA F	AB EB DD D3 A6 9B F5 EA ED F3 B6 F6 F2 EE F2 DF B3 9A B5 F3 EF DB 9D FA
CB FF B9 EF DD D6 96 96 97 9B DC 9E DD CD AF 9A A6 A6 94	A B5 BA A6 97 B7 B4 9B 96 A6 97 9F 9A B5 B4 B4	4 B9 9F 97 9F BA B7 A6 B9 B7 96 A6 9E B5 B7 9A B5 B4 9B 9B 9	3 97 97 96 B7 B7 9F 9D 9E B9 B4 B4 B9 9F 97 A6 97 BA B9 9E 9E 9F 97 9A B5
B7 9A B5 BA A6 97 9A B5 B9 9F 9F 9F B6 B5 9A 97 97 9A B5	5 B6 97 9F 9F B7 B4 B4 B4 9B 96 9B B4 B7 A6 B9	9 B5 A6 9D 97 9A B6 9B B5 9E 96 9E 97 9A 9A 9B 96 9E BB B6 9	8 B5 BA A6 9B A6 BB B4 9D 9E B5 B7 97 9B 9B A6 BA B6 97 B7 BA 9D 9B 9B 9B
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Track \$22.00 at index 2172 (\$087C)			
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Figure 14: Damaged section of Track 13 with the unknown "85" nibble replaced with "CB" so that the image would pass verification in Passport.



Figure 15: Crash in the program when trying to play though the "Depressants" section.

From this error, it was clear to me that the program was more than likely just BASIC if the copy protection could be stripped away. Luckily, we have Passport which was able to do just that and produce a readable (and bootable) copy of the program with a standard DOS 3.3 file system. Figure 16 shows the passport output as it produced a new file called "DRUGS- Their Effects On You - Disk 1, Side A - repair attempt 3 - cracked.dsk". With a version of the disk without copy protection now produced, I could easily read the file system in the disk analyzer. The filesystem appears as shown in Figure 17.

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100,503,\$35: 9F -> UE	
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Figure 16: Passport output when producing "DRUGS- Their Effects On You - Disk 1, Side A - repair attempt 3 - cracked.dsk"

• • •		DRUGS- Their E	ffects On You - Disk 1, Sid	e A - repair attempt 3 - cracked.dsk								
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CF F3 A7 D3 FE F2 FE D3 B4 F9 FC DA F4 FC 95 FA D5 F4 27 E8 E0 F3 D3 9F CF F3 FA BE F3 FD D9 D7 97 Fn BE EX EF D7 SN B4 E7 AF D0 96 77 97 Fn BE EX EF D7 SN B4 C7 D7 A7 0 00.00 Å 0 Å 0 Å 0 Å 0 Å 0 00.00 Å 0 Å 0 Å 0 Å DEK VODUM2534 Acquire 1001.33 (6) exetor) 1007 5.33° Dax	FP 08 D9 54 A 5 3 C F 4 27 09 F 61 FP 08 D9 54 A 5 3 C F 4 27 09 6 64 E 50 98 A C F 64 B F A D 00 A 5 C F 7 109 64 A 8 F 6 A D 60 ED F E F C 6 F 60 D C 10 6 64 A 6 64 A 7 A 7 A 7 A 7 A 7 A 7 A 7 A 7 A 7 A	BB 50 73 70 AB F4 FC AB F4 FC D1 BD 75 75 73 D0 B3 Ab F4 FC AB F4 FC D1 BD 75 75 73 D0 B3 Ab F4 FC AB F4 FC D1 BD 75 75 73 D0 B3 Ab F4 FC AB F4 FC D1 Store Type Store A codesent BABC 4.008 A codesent BABC 10,712 A codesent BABC 4.008 A codesent BABC 10,728 B - Binary 1,228 B - Binary 1,240 B - Binary 1,250 B - Binary	CD FE 97 FD FC AE AF	PC ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 EP FC 47 EP FC FC FC FC ED 97 EF FC F	6 AF E6 AB ED 5 AA 96 FF FE 9 AC E7 B5 D7 /	D9 BB B3 I	BC CD F3 FE	80 85 FB EI	F B5 E9 FD F FF FF FF 7 B0 EN 0E	9A DF 9A E FIF FIF DS A EC B3 B3 B3 Loading com	A EC 96 F2 (A AD 96 E6 (A EF AF AF AF AF (En Market) (En Market)	
CF F3 A7 03 FF F2 FE 03 B4 F0 FC DA F4 FC 95 FA D5 F4 27 E8 E0 F3 D3 9F CF F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 FA BE F3 F0 D9 D7 97 ED BE 64 FC F3 F4 F6	F9 08 09 64 A 5 8 C F 4 27 09 F 64 F9 08 09 64 A 5 C F 82 09 A 6 C F 7 C F0 98 A C F 70 09 A 6 C F 7 C F0 98 A 7 A 7 A 7 A 7 A 7 A 7 A 7 A 7 A 7 A	BB 50 73 FD AB F4 FC AB F4 FC D5 BD 75 F5 F3 D0 B3 AD F4 FC AB F4 FC D5 BD 75 F5 F3 D0 B3 AD F4 FC AB F4 FC D5 BD 75 F5 F3 D0 B3 AD F4 FC AB F4 FC D5 BD 75 F5 F3 D0 B3 AD F4 F0 F3 F4 F6 Size Type 4,050 A Apdisech BASC 10,712 A Appleach BASC 4,050 B - Binary 1,024 B - Binary 1,024 B - Binary 1,026 B - Binary 256 B - Binary 256 B - Binary 258 B - Binary	CO FE 97 FD FC AE AF	FC FD 97 FD FC 97 97 FC FC 88 88 98 88 FF FC 87 FC 97 FC 97 FC 97 FC 86 88 99 88 FF FC 87 FC 97 FC 97 FC 97 FC 97 FC 97 FC FC 97 FC 97 FC 97 FC 97 FC 97 FC 97 FC FC 97	8 AF E6 AB ED 5 AA 96 FF FE 0 AC 67 BK D7	D9 BB B3 I	BC CD F3 FE	80 85 FB EI	F 85 E9 FD F FF FF 7 R0 EN 0E	9A DF 9A E FIF FIF DS A EC. B3. B2. B Loading com	A EC 96 F2 (A AD 96 E6 (A BE RE RE F7 (Can Med	
CF F3 A7 D3 FE F2 FE D3 B4 F9 FC DA F4 FC 95 FA D5 F4 27 E8 E0 F3 D3 9F CF F3 FA BE F3 FD D9 D7 97 En BE EX EF D7 EN B4 E7 3 FD D9 D7 97 En BE EX EF D7 EN B4 E7 D7 OF B4 © 00.00 Å 0 Å 0 Å 0 Å DEK VOLUMEZ54 Acquise 1001.33 109 acctor) 1007 5.33° Dax	F9 08 09 54 A 55 3C F4 27 09 F6 71 F9 08 09 54 A 55 A 50 68 F7 A 30 00 A8 EC F7 F0 98 AA 56 A0 80 ED FE FC 68 60 00 F0 98 AA 56 A0 80 ED FE FC 68 60 00 F8 66 66 64 A0 A0 ED FE FC 68 80 00 F8 66 66 64 A0 A0 ED FE FC 68 80 00 F8 66 66 64 A0 A0 ED FE FC 68 80 00 F8 66 66 64 A0 A0 A0 ED FE FC 68 80 00 F8 66 66 64 A0 A0 A0 ED FE FC 68 80 00 F8 66 66 64 A0 A0 A0 ED FE FC 68 80 00 F8 66 66 64 A0 A0 A0 ED FE FC 68 80 00 F8 66 66 64 A0 A0 A0 ED FE FC 68 60 00 F8 66 66 64 A0 A0 A0 ED FE FC 68 60 00 F8 66 66 64 A0 A0 A0 ED FE FC 68 60 00 F8 66 66 66 66 66 66 66 66 66 66 66 66 66	BB 50 73 70 AB F4 FC AB F4 FC D1 BD 75 75 73 D0 B3 Ab F4 FC AB F4 FC D1 BD 75 75 73 D0 B3 Ab F4 FC AB F4 FC D1 BD 75 75 73 D0 B3 Ab F4 FC AB F4 FC D1 State Ab F4 FC AB F4 FC AB F4 FC D1 State A code State A code State A code State Binary 1,250 B - Binary 1,250 B - Binary 1,252 B - Binary 250 B - Binary </td <td>CD FE 97 FD FC AE AF</td> <td>PC ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 07 ED FC 07 105 105 105 105 105 105 105 105</td> <td>8 AF E6 AB ED 5 AA 96 FF FE 0 AF E7 BE N7</td> <td>D9 68 63 6 AA AA AB A RS DE DC D</td> <td>BC CD F3 FE</td> <td>80 85 FB EI</td> <td>F BS E9 FD F FF FF 7 R0 EN OF</td> <td>9A DF 9A E FIF FIF DS A EC. B7 B7 B Loading com</td> <td>A EC 96 F2 IA AD 96 E6 IA ER AR E7 Ent Mad</td> <td></td>	CD FE 97 FD FC AE AF	PC ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 08 B8 96 B4 FF ED 97 ED FC 97 ED FC 07 ED FC 07 105 105 105 105 105 105 105 105	8 AF E6 AB ED 5 AA 96 FF FE 0 AF E7 BE N7	D9 68 63 6 AA AA AB A RS DE DC D	BC CD F3 FE	80 85 FB EI	F BS E9 FD F FF FF 7 R0 EN OF	9A DF 9A E FIF FIF DS A EC. B7 B7 B Loading com	A EC 96 F2 IA AD 96 E6 IA ER AR E7 Ent Mad	
CF F3 A7 03 FF F2 FE 03 B4 F9 FC DA F4 FC 95 FA D5 F4 27 E8 E0 F3 D3 9F CF F3 FA BE F3 F0 D9 D7 97 ED BE 64 E7 DC 5D A4 FC F0 CF A8 © 00.00 Å 0 Å 0 Å 0 Å DESK VOLUME 254 Arein 1003 33 16 16 mort	F9 08 09 64 A 5 8 C F 4 27 09 F 61 F9 08 09 64 A 5 C F 42 09 6 A 61 C 50 98 00 C F 64 00 A 61 C F 7 C 60 98 00 C F 7 D 05 3 3 C F 64 00 A 61 C F 7 D 05 3 C F 7 MON MON P 70 A 7	BB 90 73 F0 AB F4 FC AB F4 FC D9 B0 75 75 73 D0 B3 AD F4 FC AB F4 FC D9 B0 75 75 73 D0 B3 AD F4 FC AB F4 FC D9 B0 75 75 73 D0 B3 AD F4 FC AB F4 FC D9 B0 75 75 73 D0 B3 AD F4 FC AB F4 FC D9 B0 75 75 73 D0 B3 AD F4 FC AB F4 FC D9 B0 75 75 73 D0 B3 AD F4 F0	CO FE 97 FD FC AE AF	FC FD 97 FD FC 97 97 FC CB 88 99 81 FC FD 97 FD FC 97 97 FC CB 88 99 81 FC FD 97 FD FC 97 FD FC 08 88 99 81 FC FD 97 FD FC 97 FD FC 78 FD 78 FD 78 FD 78	8 AF E6 A8 ED 5 AA 96 FF FE 6 Ar 67 BE A7	D9 BB B3 I	BC CD F3 FE	80 85 FB EI	F BS E9 FD F FF FF 7 R0 En OE	9A DF 9A E FIF FIF DS A EC. R3 R3 R Loading com	A EC 96 F2 A AD 06 E6 EC 96 E7 AC 96 E6 AC 96 E7 AC	

Figure 17: The filesystem on the disk is finally visible once the copy protection is stripped away by Passport.

Knowing that the error is on line 11232, I looked for an Applesoft BASIC program with such a line number and quickly found it in the file called MOD1. What is more this file is written on the damaged area of track 13! Opening this file in the Applesoft BASIC editor included in applesauce and looking at line 11232 I could immediately see one problem. The work "risk" is corrupted to "shsk" in the text "People who consume a pint or more of alcohol over a short period of time *risk* going into a coma...". The second problem, why it was giving an error, was not as immediately apparent. However, looking closely at the GOSUB statement on that same line shows that it is attempting to GOSUB to a non-existent line 1024. By comparing to similar statements, this was almost certainly supposed to be line 1020 or 1025. See Figure 18.



Figure 18: Listing of the MOD1 Applesoft BASIC file with the damaged line 11232 highlighted.

To correct these two errors (the corruption of "risk" and the line 1024 instead of 1020/1025) in the original disk image was going to require knowing how these changes affected the actual nibbles on the disk. Thus, I modified the file and saved it back to the disk so that I could compare the corrected version with the original and thus know how to manually fix the original disk image. Since Applesauce does not have a feature to edit the file directly, I used AppleWin the do this. First, I started to boot the "DRUGS- Their Effects On You - Disk 1, Side A - repair attempt 3 - cracked.dsk" but then did a control-reset (control-F2 in AppleWin) as soon as it showed a "]" prompt in the lower left corner. The timing was critical. If I waited too long it would have already started to load the main program and the protection code would kick in and reset the emulator instead of giving me a BASIC prompt. If I did it too soon, for some reason it would freeze when I tried to execute "LOAD MOD1". However, I eventually did it and was able to load the program and edit the offending line 11232. See Figure 19. This first attempt at a manually corrected cracked version is preserved as "DRUGS- Their Effects On You - Disk 1, Side A - repair attempt 3 - cracked and fixed.dsk"



Figure 19: Correcting the damaged line 11232 in the MOD1 program. Left: Listing before corrections; Right: Listing after first round of corrections.

With these corrections made, the program would run and would not crash as in Figure 15, but something still wasn't right. The program would not wait for the user to "Press RETURN" after displaying the message about alcohol as it should. Fixing this was going to be harder than I thought. Looking closely at the offending line and comparing it to other sections of the code, I could see that two other things didn't look right. First, the line number was obviously wrong. It is line 11232, but it is coming before line 11200 which is not correct. Second, the GOSUB 5030 appears no where else in the code and it being wrong would explain why the program isn't pausing after displaying the message about alcohol. To fix the first problem, I looked at the line numbering scheme used and it was pretty clear that that line was supposed to be 11160 (ten more than the line before it, 11150). To fix the second problem I noted that elsewhere in the program when it was supposed to pause for user input, the call was GOSUB 5300, not GOSUB 5030. With these changes made, the program worked much better, pausing after displaying the message, but the graphics were corrupted on that screen with part of the previous screen still being shown. Still not sure if the first GOTO was supposed to be 1025 or 1020, I tried using 1020 instead of 1025 and, woot, it all seemed to work. Figure 20 shows the final corrected version of the damaged line of code. This version of the disk is preserved as "DRUGS- Their Effects On You - Disk 1, Side A - repair attempt 3 - cracked - Copy.dsk"



Figure 19: Correcting the damaged line 11232 in the MOD1 program. Left: Listing before corrections; Right: Listing after second and final round of corrections.

At this point I had a working and cracked version of the program. However, my goal was to repair the damage to the original image to produce an archival version of the original software. But, before these corrections could be made to the original uncracked image, another mystery had to be solved. After loading a program (ex. MOD2) from this disk in AppleWin, editing it, and saving it back, I found that the binary representation of the resaved file did not match the original as compared in applesauce. After a bit of investigation of how Applesoft Basic programs are stored in binary, I determined that the memory addresses stored in the file were different between the original and resaved versions of a program. See Figure 21. Comparing these addresses shows a constant offset of 0x3804. For example, the first address for the original program (right side in Figure 21) after correcting for little endian is 0x4011. The first address for the resaved program is 0x080D (left side in Figure 20). The difference between 0x4011 and 0x080D is 0x3804 or 14340 in decimal. Per

https://retrocomputing.stackexchange.com/questions/1919/apple-ii-applesoft-basic-memorymanagement the address in memory that an Applesoft program is stored at can be changed by modifying the values in memory at locations decimal 103 and 104. The default location for Applesoft to save a program at is 0x0801, so if this is added to the offset of 0x3804 we get a final location of 0x4005. To make sure the program is saved at this new location we can execute POKE 104,64: POKE 103,5: POKE 16389,0 where that last POKE assures that the first address in the block of memory that will store the program is zero as is apparently required. With these steps completed, I was able to verify that I could load and resave MOD2 with no changes to the resulting disk image (except for one stray byte... I am not sure what that is about but it is in another sector away from the damaged area, so is of no concern to me for the purpose of comparing the repaired sector.)

	ORIGINAL						MOD2					COMPARISON	
0	01 39 0D 08	00 00 A5 AB	36 33 30 30	30 00 15 08	04 00 AB 34	.9+4	01 39 11 40	00 00 A5 AB	36 33 30 30	30 00 19 40	04 00 AB 34	.9.@%+63000@+4	
14	30 00 38 08	05 00 B2 20	20 20 20 20	4D 4F 44 55	4C 45 20 32	0.82 MODULE 2	30 00 3C 40	05 00 B2 20	20 20 20 20	4D 4F 44 55	4C 45 20 32	0.<@2 MODULE 2	
28	20 30 31 2F	30 39 2F 38	37 20 20 56	45 52 20 31	00 5E 08 06	01/09/87 VER 1.^	20 30 31 2F	30 39 2F 38	37 20 20 56	45 52 20 31	00 <mark>62 40</mark> 06	01/09/87 VER 1.b@.	
30	00 BA 22 53	41 56 49 4E	47 20 4D 4F	44 32 22 3A	BA E7 28 34	.:"SAVING MOD2"::g(4	00 BA 22 53	41 56 49 4E	47 20 4D 4F	44 32 22 3A	BA E7 28 34	.:"SAVING MOD2"::g(4	
50	29 22 53 41	56 45 20 4D	4F 44 32 22	3A B3 00 <mark>8F</mark>	08 28 00 51)"SAVE MOD2":3(.Q	29 22 53 41	56 45 20 4D	4F 44 32 22	3A B3 00 93	40 28 00 51)"SAVE MOD2":3@(.Q	
64	57 D0 E2 28	31 30 32 32	29 3A 4C 53	D0 E2 28 31	30 32 31 29	WPb(1022):LSPb(1021)	57 D0 E2 28	31 30 32 32	29 3A 4C 53	D0 E2 28 31	30 32 31 29	WPb(1022):LSPb(1021)	
78	C8 C6 E2 28	31 30 32 31	29 3A AD 4C	53 CF 34 C4	4C 53 DØ 4C	HFb(1021):-LS04DLSPL	C8 C6 E2 28	31 30 32 31	29 3A AD 4C	53 CF 34 C4	4C 53 DØ 4C	HFb(1021):-LS04DLSPL	
8C	53 C9 34 00	A9 08 2D 00	BØ 36 31 30	30 30 3A AD	E2 28 31 30	SI4.)061000:-b(10	53 C9 34 00	AD 40 2D 00	B0 36 31 30	30 30 3A AD	E2 28 31 30	SI4@061000:-b(10	
AØ	32 30 29 D0	33 C4 32 30	30 00 CC 08	32 00 50 43	DØ 50 25 28	20)P3D200.L.2.PCPP%(32 30 29 D0	33 C4 32 30	30 00 D0 40	32 00 50 43	DØ 50 25 28	20)P3D200.P@2.PCPP%(
B4	4C 53 29 3A	514ED051	25 28 4C 53	29 3A 53 53	25 DØ 53 25	LS):QNPQ%(LS):SS%PS%	4C 53 29 3A	514ED051	25 28 4C 53	29 3A 53 53	25 DØ 53 25	LS):QNPQ%(LS):SS%PS%	
C8	28 4C 53 29	00 F1 08 62	00 B0 31 30	30 3A B4 4C	53 AB 31 30	(LS).q.b.0100:4LS+10	28 4C 53 29	00 F5 40 62	00 B0 31 30	30 3A B4 4C	53 AB 31 30	(LS).u@b.0100:4LS+10	
DC	30 30 30 2C	31 30 33 30	30 2C 31 30	36 30 30 2C	31 30 39 30	000,10300,10600,1090	30 30 30 2C	31 30 33 30	30 2C 31 30	36 30 30 2C	31 30 39 30	000,10300,10600,1090	
FØ	30 00 4D 09	64 00 AF BD	34 3A 53 44	24 D0 22 20	22 C8 53 44	0.M.d./=4:SD\$P" "HSD	30 00 51 41	64 00 AF BD	34 3A 53 44	24 D0 22 20	22 C8 53 44	0.QAd./=4:SD\$P" "HSD	
104	24 28 53 53	25 29 C8 EA	28 E4 28 51	4E 29 2C 31	C8 32 CA 28	\$(SS%)Hj(d(QN),1H2J(24 28 53 53	25 29 C8 EA	28 E4 28 51	4E 29 2C 31	C8 32 CA 28	\$(SS%)Hj(d(QN),1H2J(
118	53 53 25 D1	CF 31 31 29	29 C8 22 20	22 3A AF BA	53 44 24 2C	SS%Q011))H" ":/:SD\$,	53 53 25 D1	CF 31 31 29	29 C8 22 20	22 3A AF BA	53 44 24 2C	SS%Q011))H" ":/:SD\$,	
12C	31 34 30 2C	30 2C 32 2C	43 53 2C 32	3A 53 44 25	DØ 28 28 E3	140.0.2.CS.2:SD%P((c	31 34 30 2C	30 2C 32 2C	43 53 2C 32	3A 53 44 25	DØ 28 28 E3	140.0.2.CS.2:SD%P((c	

Figure 21: Memory addresses in BASIC program have changed after loading and resaving it. The left file is the resaved version, and the right file is the original one from the disk.

With a process for loading and resaving programs figured out, I could now attempt to correct the damage to MOD1 and then see if the resulting changes on the disk "made sense" in terms of where the original damage on the disk was. Note that the location where MOD1 is stored is slightly different then where MOD2 is stored – 0x4001 instead of 0x4005 so the POKE statement needs to be POKE 104,64: POKE 103,1: POKE 16385,0. With these pokes done, and MOD1 resaved, I could finally compare the flux streams for the original and the repaired images. After a bit of manual work to locate the changes on the disk and to manually compare the flux streams for the damaged and repaired sector, much to my delight all the repairs resulted in changes to only a few nibbles, and all were right on top of the damaged section! This strongly indicated that my repairs were correct as incorrect repairs would have likely resulted in changes far away from the damaged section. See Figure 22.



Figure 22: Comparison of the corrected and original versions of the damaged area of the disk. The upper flux stream diagram is for the repaired version and the lower is for the original version. Note that the "original version" shown here already has had the "shsk / risk" corruption repaired. Note that the 5th nibble "EF" here is the first nibble shown in Figure 14.

With the repairs made in the flux editor, I saved the .a2r and exported a .woz. Nervously, I loaded up Passport in AppleWin and did a verification. Watching the track indicator in AppleWin, I let out a cheer when it passed Track 13 without any errors! My repairs had resulted in a valid checksum – another indication that they are correct! Finally, I restarted the emulator to boot the game. Woot again! I could play though the "Depressants" module with no errors at all.

The final repaired image files are "DRUGS- Their Effects On You - Disk 1, Side A – Fixed.a2r" and "DRUGS- Their Effects On You - Disk 1, Side A – Fixed.woz". Enjoy!