

June 25, 2013

Chip May, Executive Director
Camp Arcadia
3046 Oak Street, P.O. Box 229
Arcadia, MI 49613

Re: SandGrabber Report

Dear Mr. May;

This letter is intended to serve as the final report on the SandGrabber (SG) system placed on your beach over the last two years. Placement of the SG modules was permitted by the State of Michigan as an experimental system, with its removal mandated after a three-year trial. Five surveys were performed to quantify the gains and losses that occurred during the study period. Since then, SandGrabber has changed its name to SandSaver, so any reference to SG is intended to mean either name.

Shore protection at Camp Arcadia beach goes back to at least 1978, when the existing wooden walls and groins were installed. Most of the substantial additions and maintenance took prior to 1987. The continued deterioration of these structures initiated a deliberate search for solutions to their vulnerability, being situated so close to the Lake Michigan shore. Due to the camp's previous shore protection efforts, they are not in a high risk erosion zone. However, immediately north and south of the camp, the state has measured the 60 year recession rates to be 105' and 85' respectively. This amount of beach and bluff recession at Camp Arcadia would result in the loss of their most essential buildings.

After soliciting proposals from a number of consultants and contractors, the camp's beach committee selected SandGrabber, who was willing to install a limited number of SG modules at no cost, in an effort to gain positive data to be used for future marketing. Ledy Design Group (now LSG) performed the initial topographic survey used to facilitate design, layout and permitting efforts. The State of Michigan issued a permit on 11/20/09 and the US Army Corps of Engineers issued a permit on 11/29/10. The extra 1 year to obtain the federal permit created a time crunch that forced removal of the SG modules in April, 2013 after only five surveys, instead of the 7 originally contemplated.

In retrospect, the SG system should have been left in place longer, in order to witness its response to the rising Lake Michigan water levels we are now experiencing. Instead the modules were in place during historically low water levels. This would have given all parties additional information regarding SG performance over a larger range of conditions that can be expected over a standard service life.

Attachments to this report illustrate the changes that occurred, and consist of overlapping survey profiles and a spreadsheet that quantifies these changes into square feet at each cross-section and cubic yards between each section. Additionally, I broke the beach into 4 quadrants to assist in visualizing trends based upon proximity to the SG installation.

The results of the shoreline in response to the SG system are unambiguously positive. Of the 2,567 cubic yards (cy) of beach volume gain from April 2011 to April 2013, 37% of the gain (954 cy) occurred at the SG installation, which constituted only 25% of the surveyed beach length. This equates to a gain of 6.4 cy per foot of beach front at the SG location, compared with a gain of 3.6 cy/ft over the rest of the study area.

Beach volume gains did not just occur behind the SG modules, as some had anticipated. Tangible gains in bottom elevation were witnessed as much as 50' in front of the SG system into the lake. This benefit was also visited upon the beach immediately north of the installation, which is downdrift at this location on Lake Michigan. This portion of the beach gained 6.1 cy/ft, when standard expectations were it would lose profile if the SG system was successful at "grabbing" any sand. This result appears to show that, at the very least, the SandGrabber design does not generate adjacent negative impacts associated with shore-normal and impermeable structures. The SG modules' permeability and placement in a shore-parallel orientation demonstrated no negative impacts to adjacent stretches of beach.

Summary of Monitoring Surveys at Camp Arcadia's Lake Michigan Beach

<u>Quadrant</u>	<u>Location</u>	<u>ΔVol.</u>	<u>Average ΔVol.</u>
1	Sta 5+00 to 6+75	+329 cy	1.9 cy/ft
2	Sta 6+75 to 8+25	+522	3.5
3	Sta 8+25 to 9+75	+954	6.4 ← location of SandGrabber system
4	Sta 9+75 to 11+00	+761	6.1
Total	Sta 5+00 to 11+00	+2567 cy	4.3 cy/ft

It has been a distinct pleasure to work for you and your colleagues in the interest of protecting Camp Arcadia and preserving its beach. Please feel free to contact me when further discussion or action becomes warranted.

Respectfully,

David L. Schultz, P.E.

cc: Barry Peterman, MDEQ
James Kohlenberg, Sand Saver

YOUNGS CONSULTING
14154 RUBY LANE
BIG RAPIDS, MI. 49307
TELEPHONE 231-510-4216 FAX 231-832-1947

Date: June 16, 2013

To Whom It May Concern:

From: Cliff Youngs, P.E.

Subject: Survey equipment and procedures

To Whom It May Concern::

Please find listed below the information you have requested regarding the hydrographic surveying equipment used by Youngs Consulting:

- Innerspace 455 XPe 200KHZ sounder – put into service in 2006
- 208KHz 3 degree XDCR transducer – put into service in 2006
- Raven Invicta 210 GPS receiver – put into service fall of 2005
- Hypack Max Hydrographic Survey Version 2012a

Please find below the methodology and equipment used by LCM Surveying and Engineering:

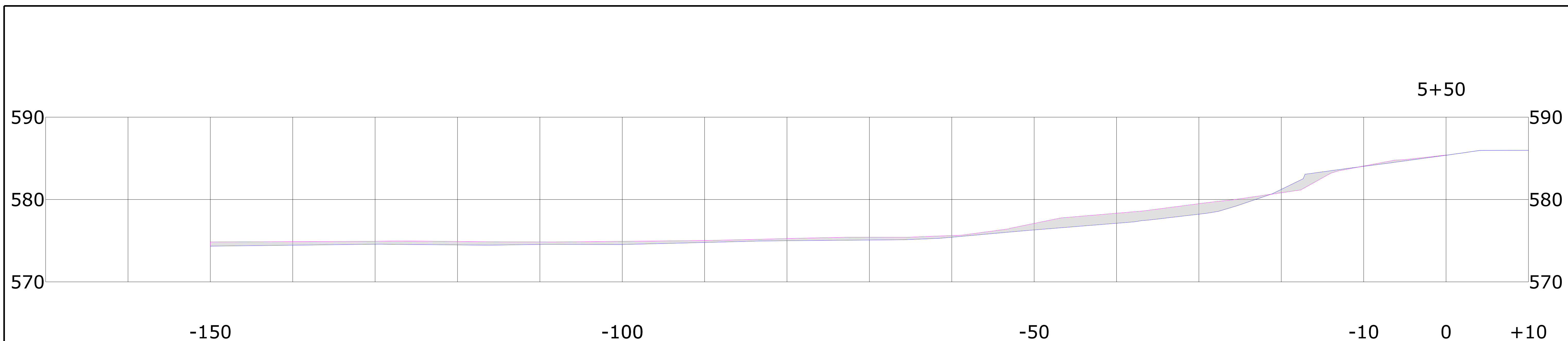
LCM Surveying & Engineering performed the upland portion of the topographic survey by utilizing Leica System 1200 GNSS GPS Receivers. We used a Base/Rover system referenced to the Michigan CORS GPS Network. We established the baseline, stationing and control for this project by using previous survey control established by LEDY Survey Group, who had previously completed a survey for the Lutheran Camp Association.

This survey control was used to establish reference lines at 25' intervals along the established baseline. Survey data was collected along said reference lines for each monitoring survey. Since data was collected along a common reference line the data could be compared with previous surveys looking for any variations.

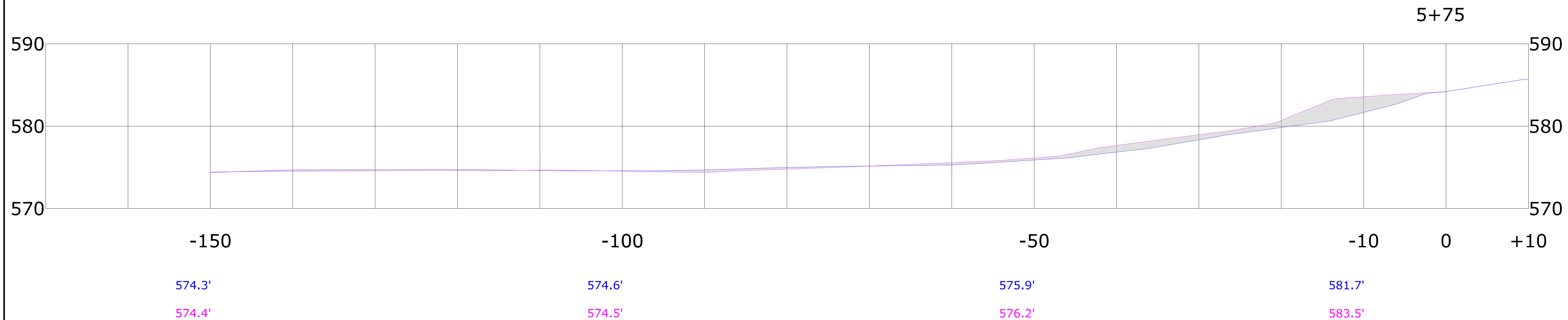
Please contact me for any questions.

Camp Arcadia		Volumetrics														
Change, 4/13/11 to 9/1/11				Change, 9/1/11 to 4/17/12			Change, 4/17/12 to 9/6/12			Change, 9/6/12 to 4/12/13			4/13/11 to 4/12/13			
c.s. area change		volume		c.s. area change		volume	c.s. area change		volume	c.s. area change		volume	Cum. volume change			
Station	loss (sf)	gain (sf)	change (cy)	loss (sf)	gain (sf)	change (cy)	loss (sf)	gain (sf)	change (cy)	loss (sf)	gain (sf)	change (cy)	loss (sf)	gain (sf)	change (cy)	cubic yards
5+00	0.7	90.0		70.7	8.8		1.9	151.8		147.0	4.0					
5+25	0.0	98.4	86.9	39.4	10.4	-42.1	4.7	134.9	129.7	104.0	38.0	-96.8				77.7
5+50	6.2	67.0	73.7	9.9	21.4	-8.1	3.2	119.5	114.1	159.0	12.0	-98.6				81.1
5+75	9.1	51.2	47.6	15.7	32.8	13.2	1.8	105.6	101.9	125.0	9.0	-121.8				41.0
6+25	24.9	4.9	20.5	8.3	64.5	67.9	56.9	24.6	66.2	11.0	37.0	-83.3				71.2
6+50	42.8	17.7	-20.9	0.8	75.8	60.7	68.8	22.0	-36.6	22.0	38.0	19.4				22.7
6+75	42.2	20.6	-21.6	2.0	67.8	65.2	56.2	24.7	-36.3	10.0	55.0	28.2				35.6
7+00	54.9	19.2	-26.5	5.8	56.1	53.8	47.9	31.8	-22.0	18.0	57.0	38.9				44.1
7+25	36.3	102.4	14.1	11.4	56.3	44.1	55.8	38.0	-15.7	17.0	49.0	32.9				75.3
7+50	76.3	27.2	7.9	15.4	67.1	44.7	37.3	34.4	-9.6	8.0	64.0	40.7				83.8
7+75	58.6	6.2	-47.0	0.4	95.8	68.1	22.6	38.6	6.1	22.0	41.0	34.7				61.9
8+00	20.6	48.4	-11.4	15.6	95.1	81.0	23.5	13.6	2.8	18.0	70.0	32.9				105.3
8+25	13.8	36.3	23.3	7.2	43.7	53.7	3.0	39.1	12.1	16.0	100.0	63.0				152.1
8+50	23.5	28.6	12.8	15.0	30.2	23.9	52.4	9.1	-3.3	11.0	114.0	86.6				120.0
8+75	59.7	34.4	-9.4	9.9	48.7	25.0	0.0	95.5	24.2	50.0	75.0	59.3				99.1
9+00	32.6	57.9	0.0	20.6	46.8	30.1	8.8	78.2	76.3	19.0	113.0	55.1				161.5
9+25	67.1	35.1	-3.1	10.6	89.2	48.5	27.3	56.0	45.4	4.0	146.0	109.3				200.1
9+50	51.2	28.0	-25.6	7.7	30.3	46.9	18.3	47.6	26.9	0.0	187.0	152.3				200.5
9+75	92.1	23.6	-42.5	12.0	52.5	29.2	18.3	51.0	28.7	1.0	154.0	157.4				172.9
10+00	87.1	20.7	-62.5	15.4	51.9	35.6	34.4	54.1	24.3	0.0	182.0	155.1				152.5
10+25	64.3	10.2	-55.8	1.1	51.2	40.1	38.9	37.9	8.7	5.0	186.0	168.1				161.0
10+50	61.7	24.6	-42.2	20.2	49.8	36.9	47.1	45.1	-1.4	8.0	138.0	144.0				137.3
10+75	59.0	9.6	-40.0	15.3	78.7	43.1	61.5	34.5	-13.4	1.0	208.0	156.0				145.6
11+00	46.7	19.7	-35.4	29.3	32.7	30.9	53.2	40.7	-18.3	4.0	202.0	187.5				164.8
			-157.0			892.4			510.7			1320.8				2566.9

Red stations and values are at SandGrabber installation location



		END AREA (SQ FT)	VOLUME (CYD)
5+50.00 EX	Excavation	6.2	3
	Fill	67.0	77
5+75.00 EX	Excavation	9.1	7
	Fill	51.2	55



LAKE MICHIGAN

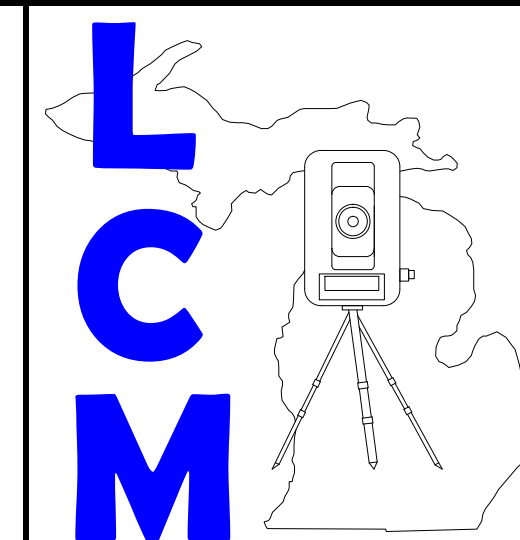
(WATER ELEV:576.9'±, APRIL 13, 2011)

04-13-2011

(WATER ELEV:577.9'±, SEPTEMBER 01, 2011)

09-01-2011

SCALE 1"=6'



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- **Civil Engineering**

**225 EAST MAIN ST.
MARION, MI 49665
Phone: (231) 743-3000
Fax: (231) 743-3001**

MONITORING BEACH TOPOGRAPHY

PROJECT:

LOCATION:

**PART OF THE
SECTION 10, T24N, R16W, ARCADIA TWP.,
MANISTEE CO., MICHIGAN.**

ENGINEERING FIRM:

**YOUNGS CONSULTING
14154 RUBY LANE
BIG RAPIDS, MI 49307**

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DATE: 03-12-2013

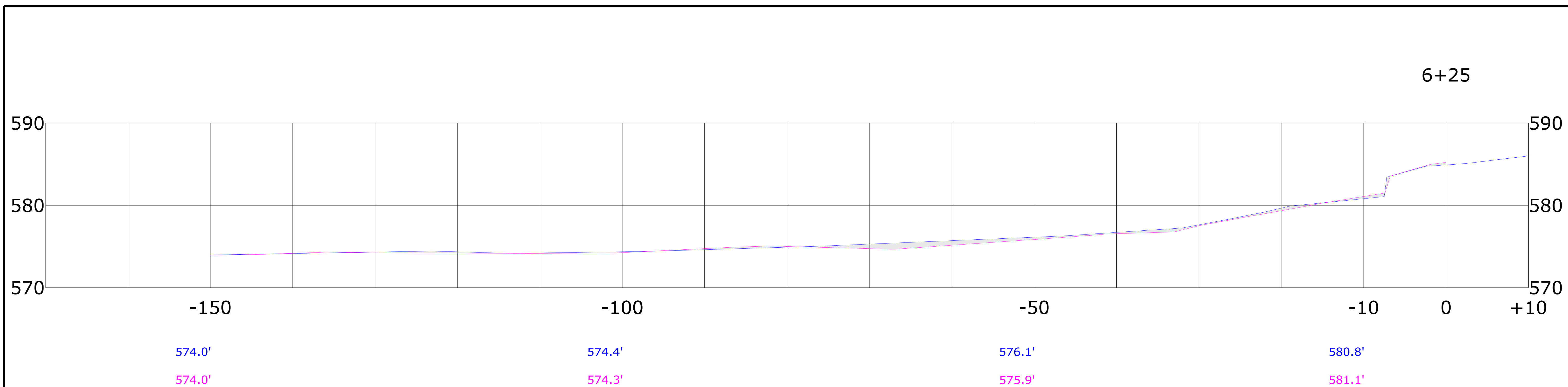
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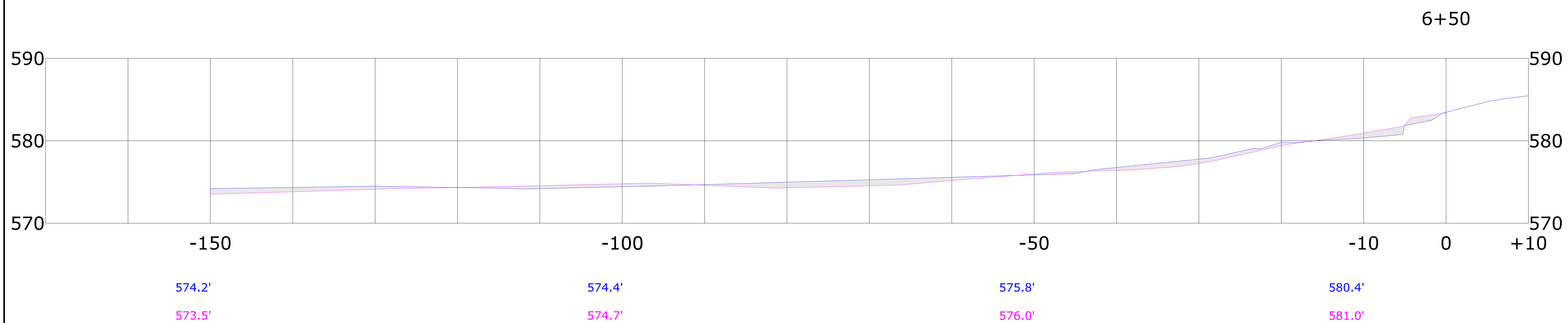
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		END AREA (SQ FT)	VOLUME (CYD)
6+25.00 EX	Excavation	24.9	31
	Fill	4.9	52
6+50.00 EX	Excavation	42.8	31
	Fill	17.7	10



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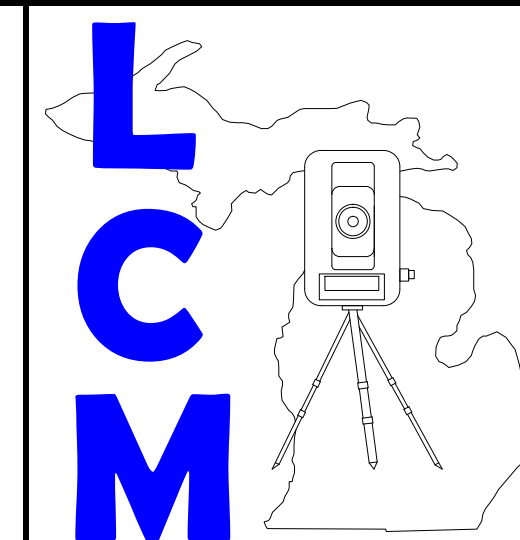
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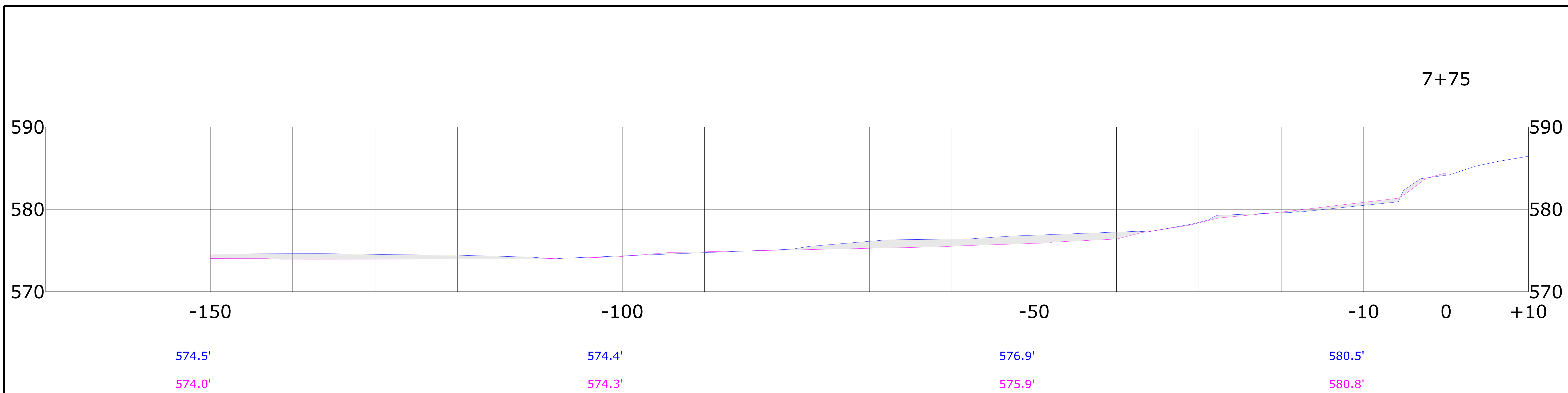
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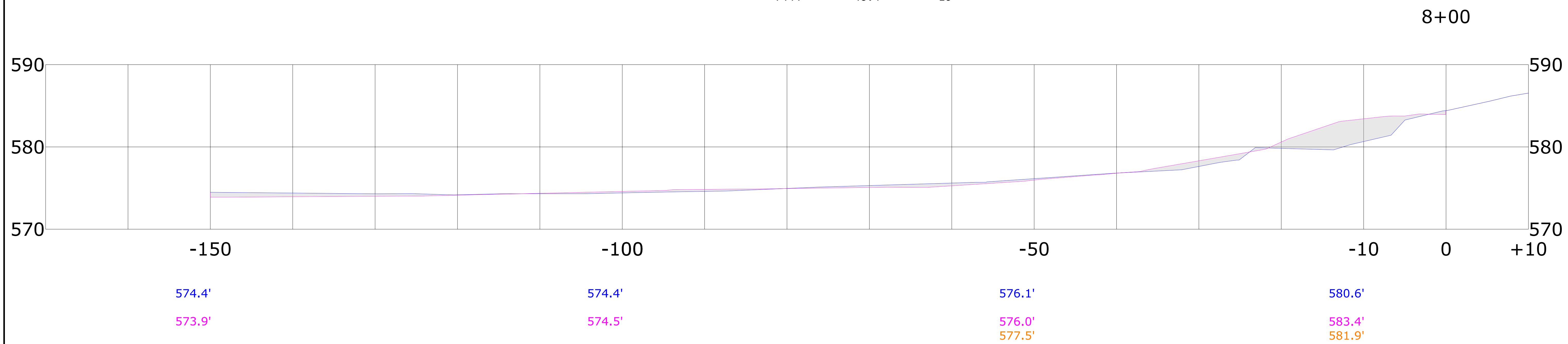
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		END AREA (SQ FT)	VOLUME (CYD)
7+75.00 EX	Excavation	58.6	62
	Fill	6.2	15
8+00.00 EX	Excavation	20.6	37
	Fill	48.4	25



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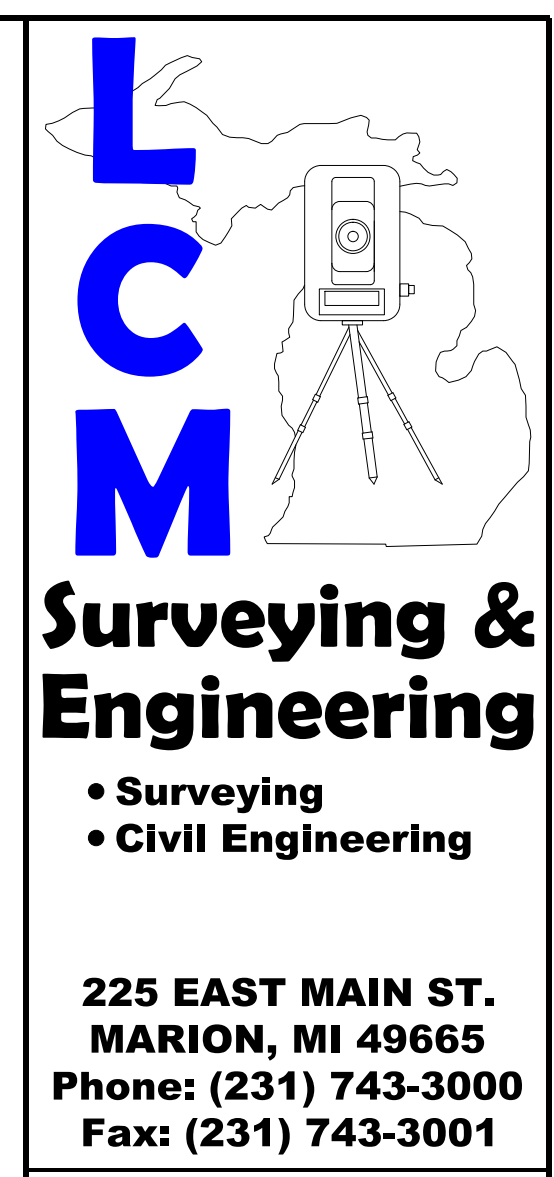
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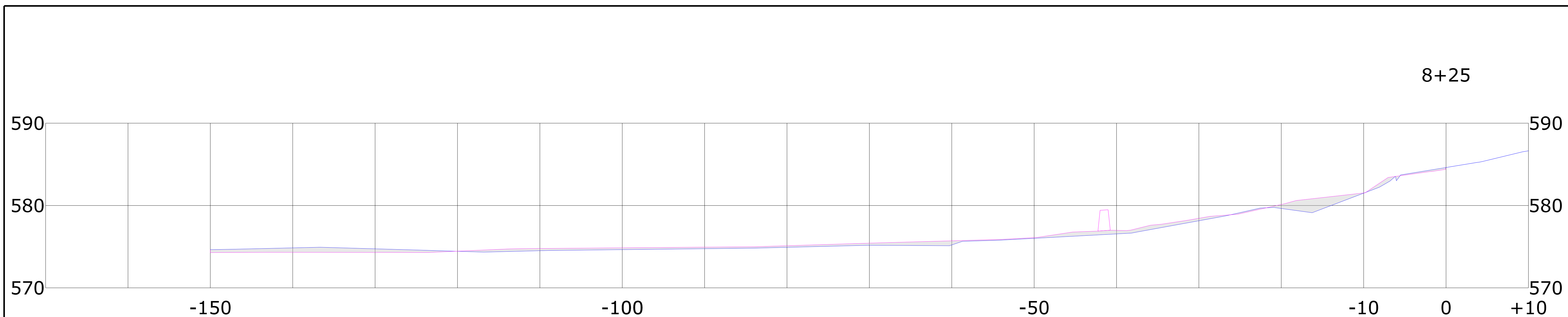
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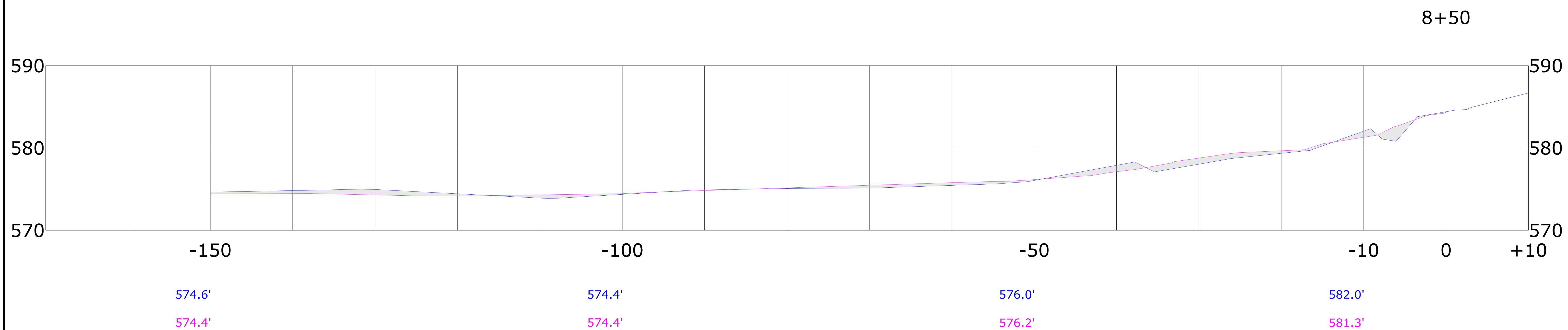
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		END AREA (SQ FT)	VOLUME (CYD)
8+25.00 EX	Excavation	13.8	16
	Fill	36.3	39
8+50.00 EX	Excavation	23.5	17
	Fill	28.6	30



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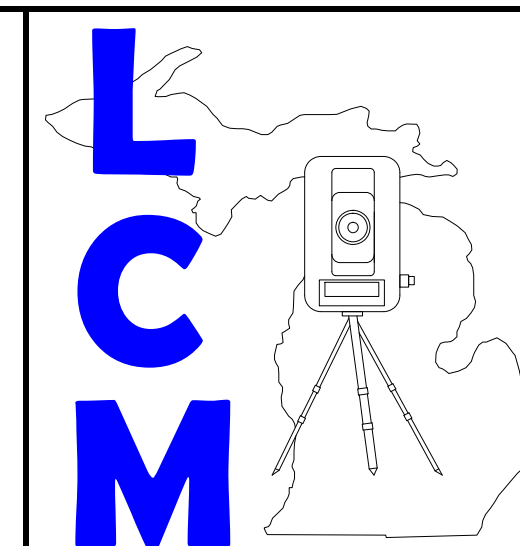
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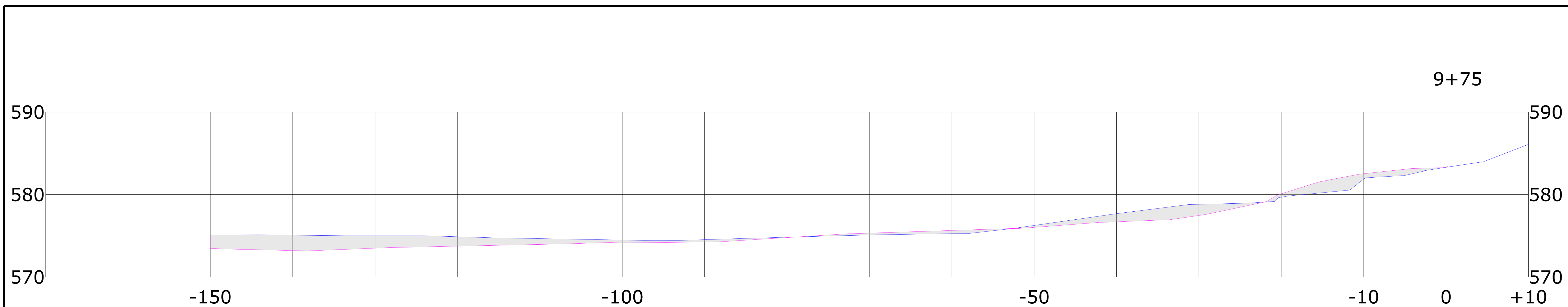
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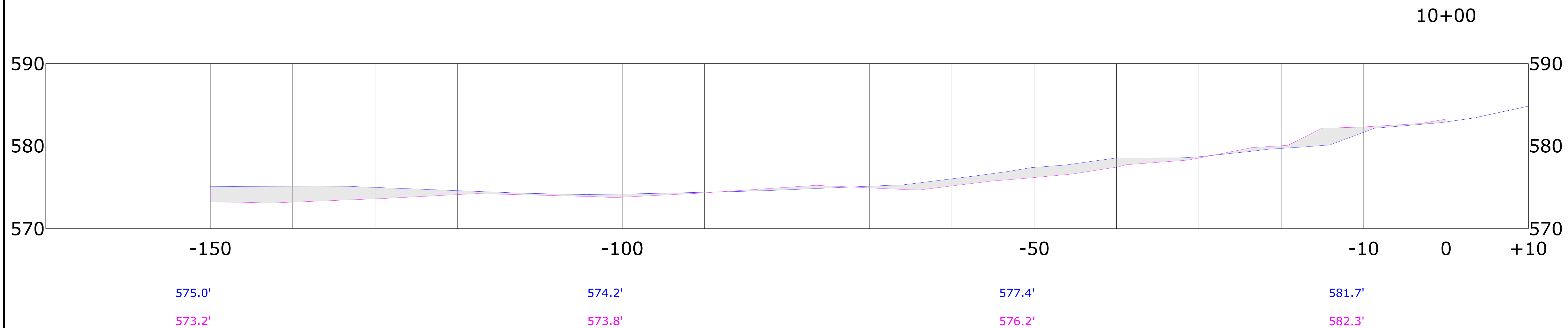
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		END AREA (SQ FT)	VOLUME (CYD)
9+75.00 EX	Excavation	92.1	66
	Fill	23.6	24
10+00.00 EX	Excavation	87.1	83
	Fill	20.7	21



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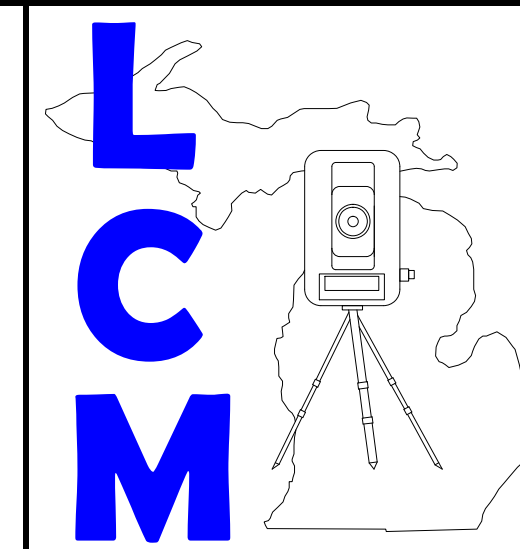
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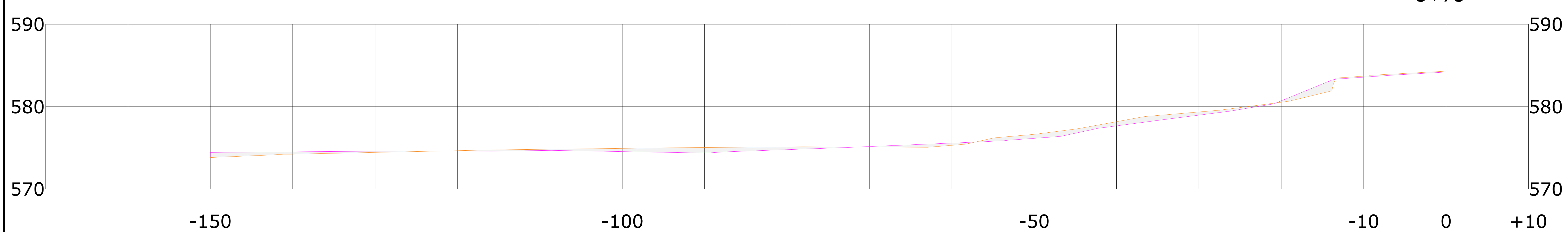
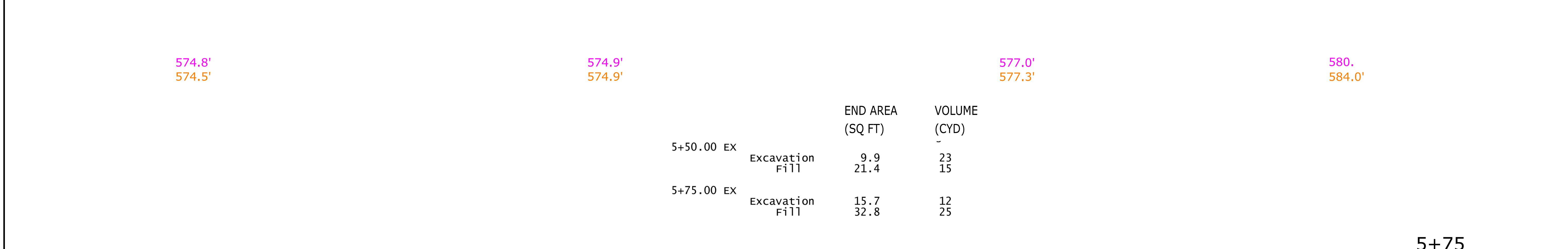
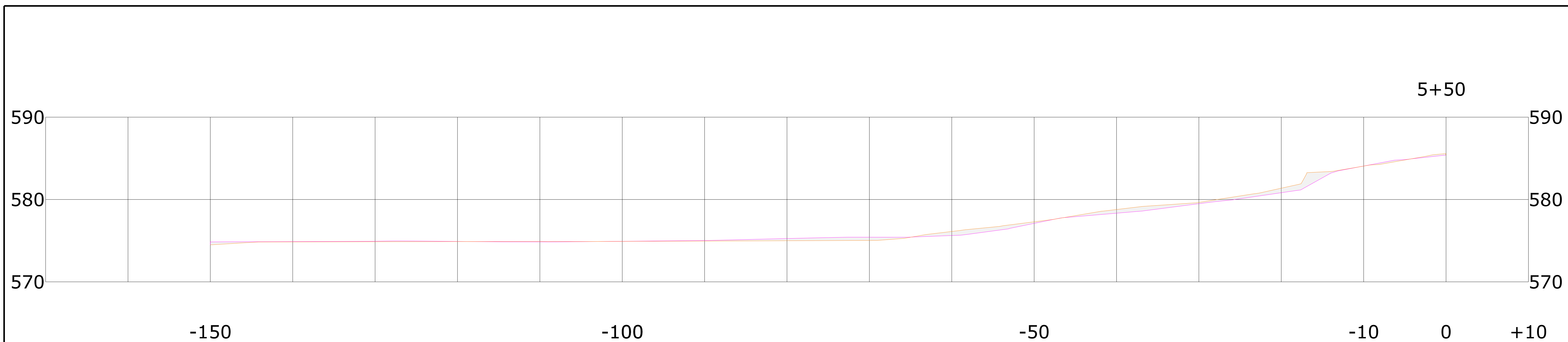
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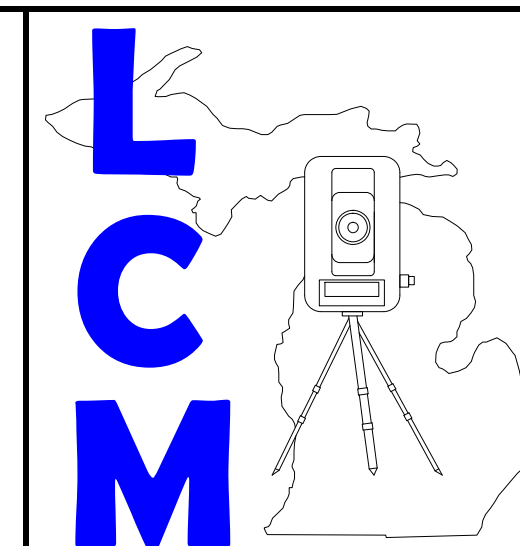
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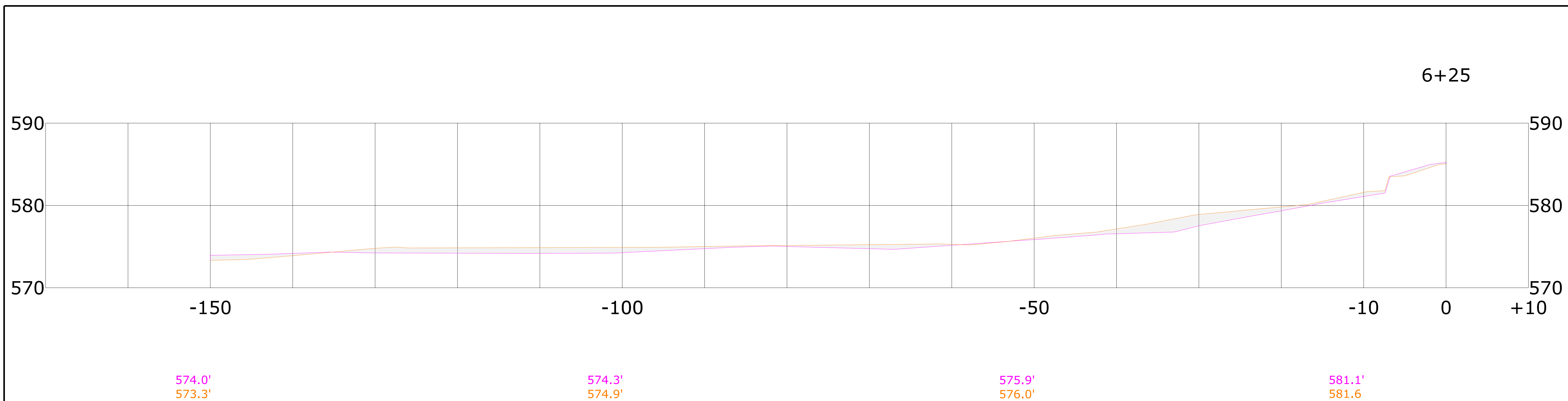
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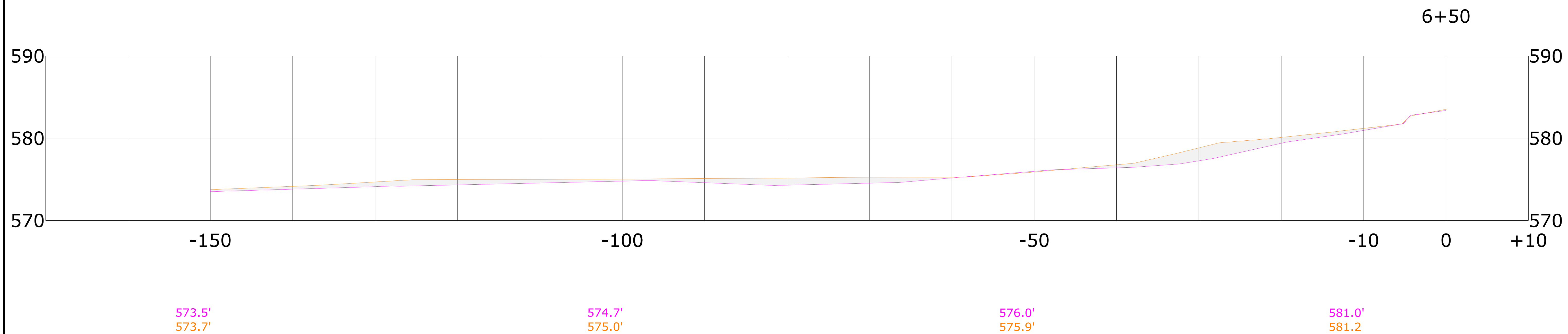
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3 OF 13



		END AREA (SQ FT)	VOLUME (CYD)
6+25.00 EX	Excavation	8.3	22
	Fill	64.5	90
6+50.00 EX	Excavation	0.8	4
	Fill	75.8	65



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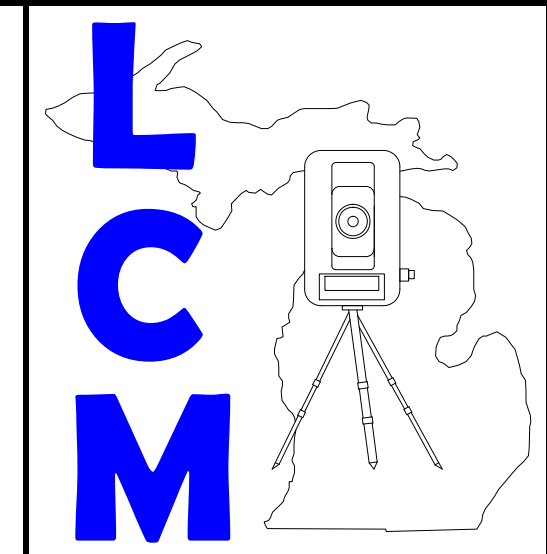
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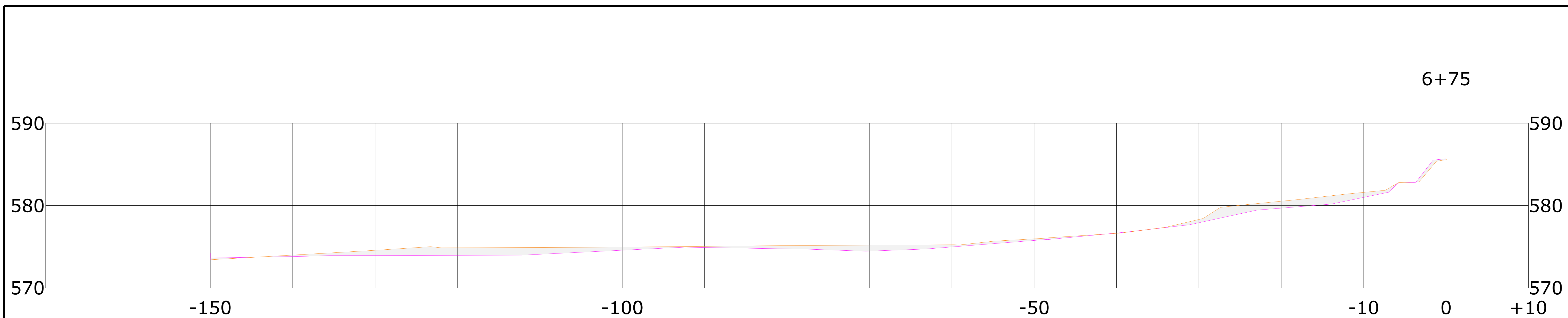
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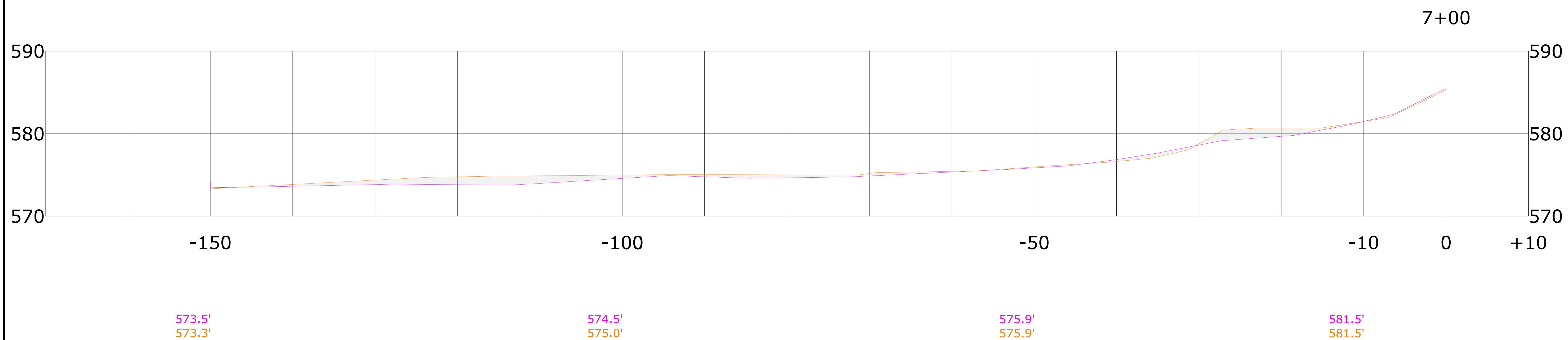
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4 OF 13



		END AREA (SQ FT)	VOLUME (CYD)
6+75.00 EX	Excavation Fill	2.0 67.8	1 66
7+00.00 EX	Excavation Fill	5.8 56.1	4 57



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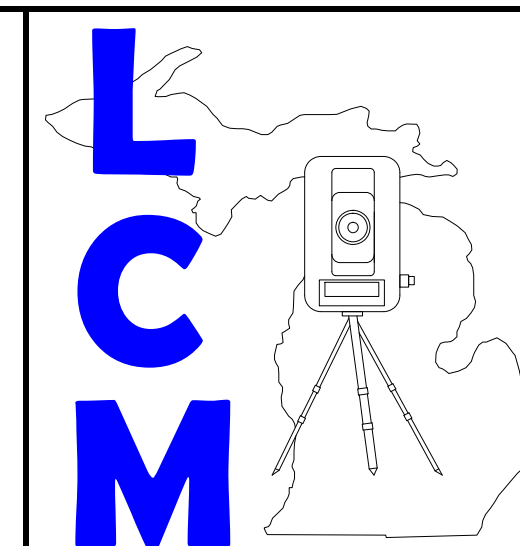
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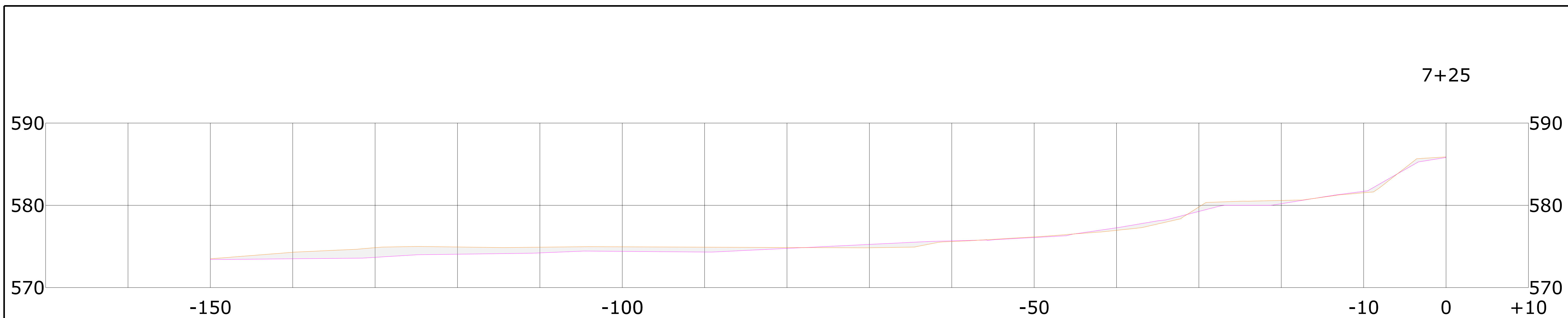
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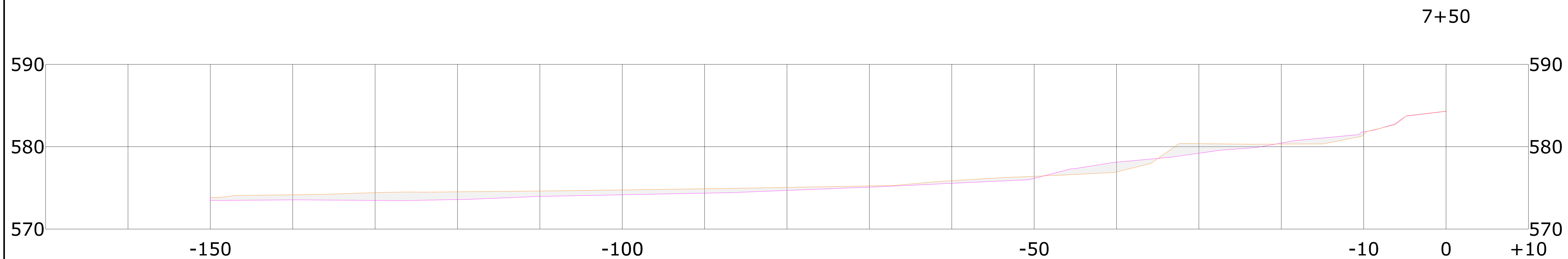
10046

SHEET NO.:

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		END AREA (SQ FT)	VOLUME (CYD)
7+25.00 EX	Excavation Fill	11.4 56.3	8 52
7+50.00 EX	Excavation Fill	15.4 67.1	12 57



LAKE MICHIGAN

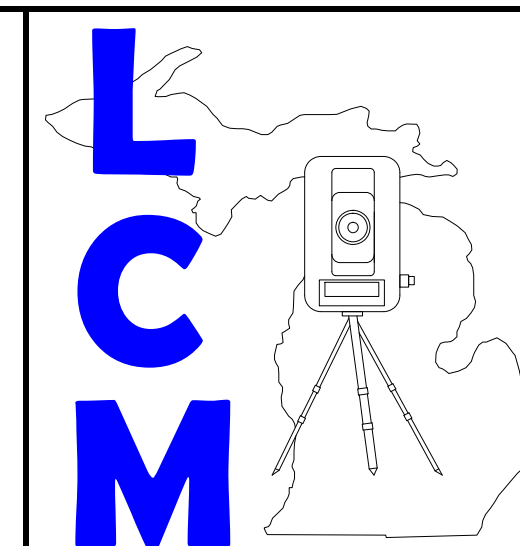
(WATER ELEV:577.9'±, SEPTEMBER 01, 2011)

(WATER ELEV:577.5'±, APRIL 17, 2012)

09-01-2011

04-17-2012

SCALE 1"=6'



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BIG RAPIDS, MI 49307**

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DATE: _____

3-12-2013

FIELD BOOK

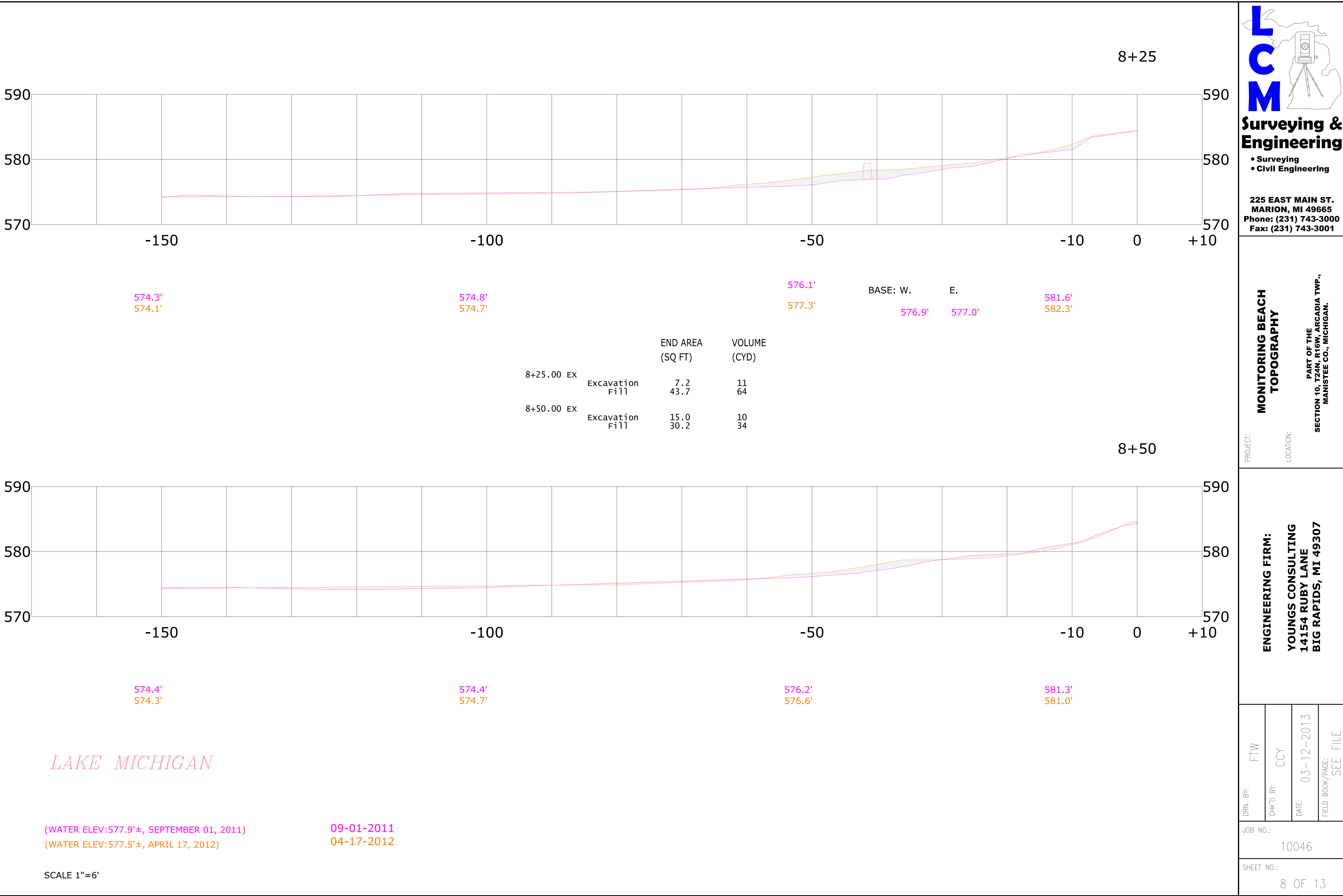
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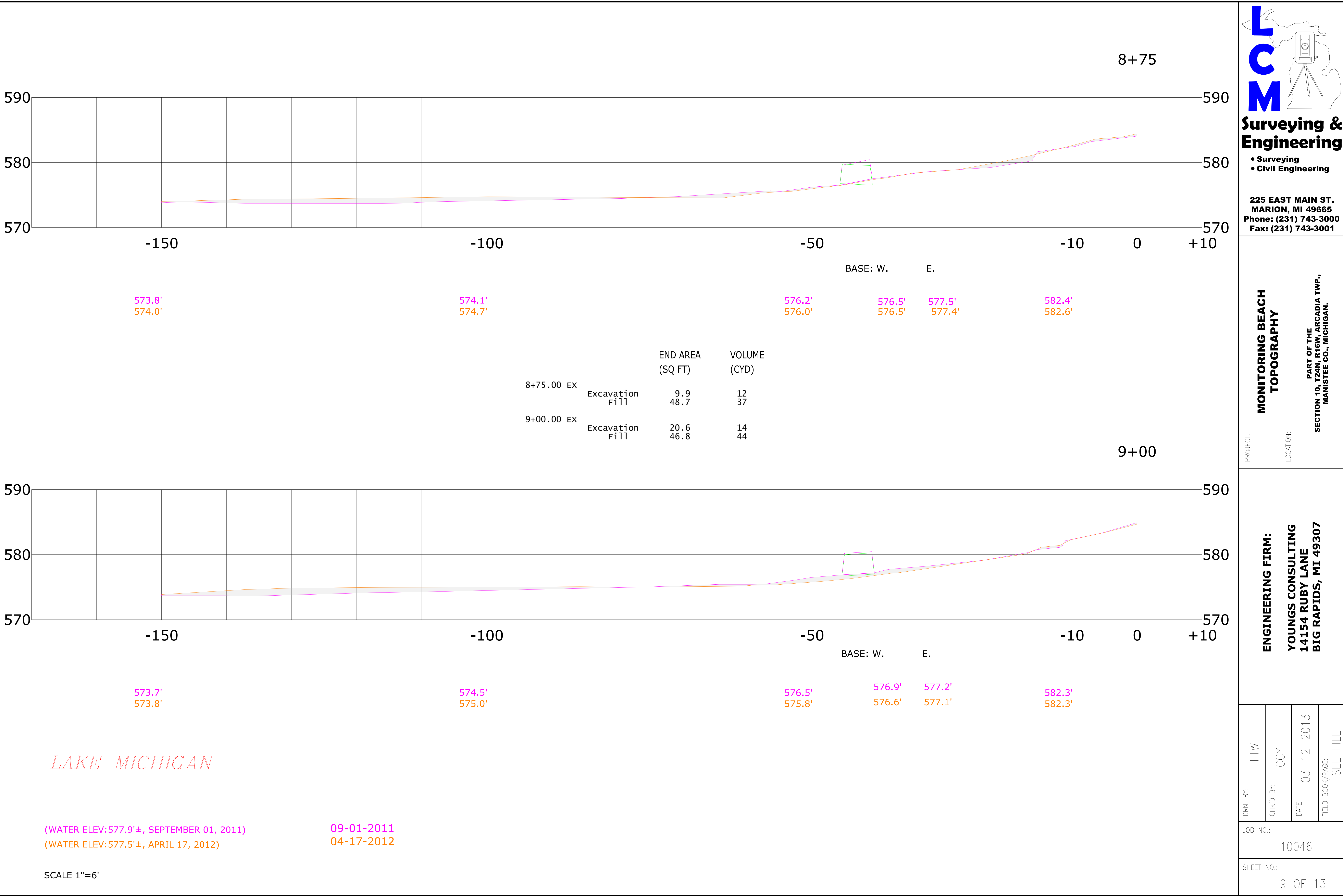
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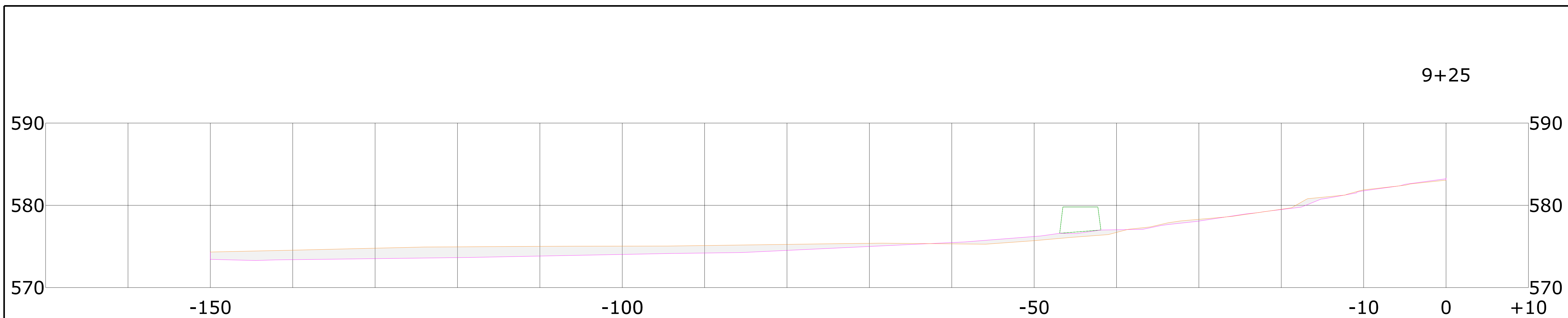
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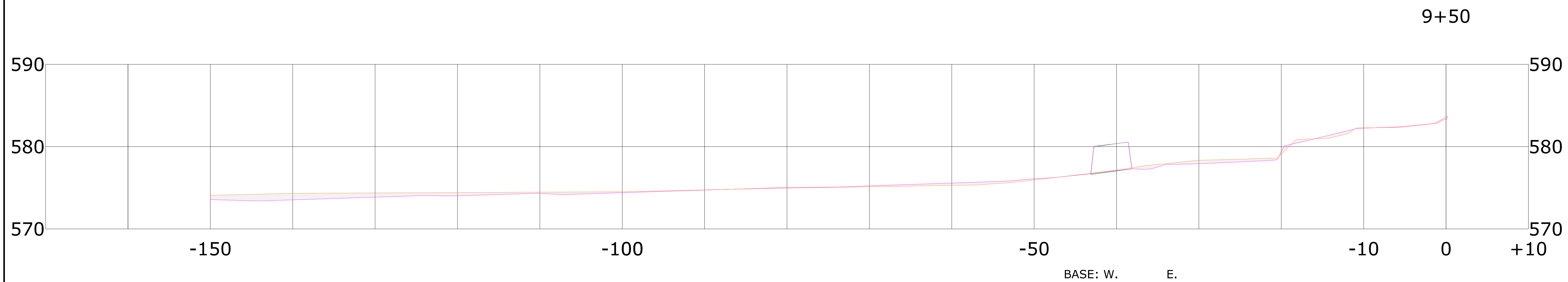
6 OF 13







		END AREA (SQ FT)	VOLUME (CYD)	576.2' 575.7'	576.6' 576.3'	577.0' 576.7'	581.7' 581.9'
9+25.00	EX						
	Excavation	10.6	14				
	Fill	89.2	63				
9+50.00	EX						
	Excavation	7.7	8				
	Fill	30.3	55				



LAKE MICHIGAN

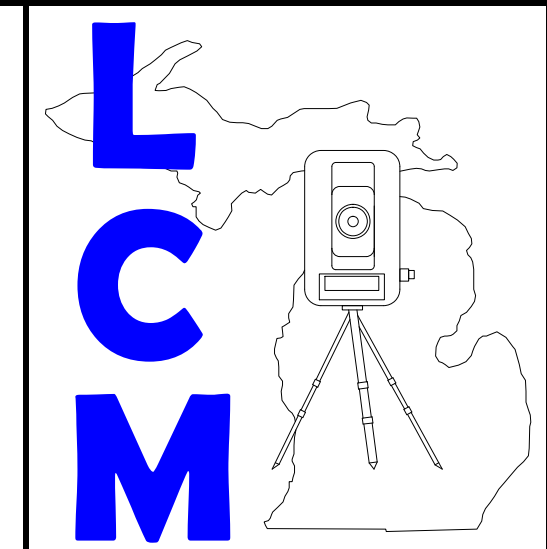
(WATER ELEV:577.9'±, SEPTEMBER 01, 2011)

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SCALE 1"=6'



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DATE: 03-12-2013

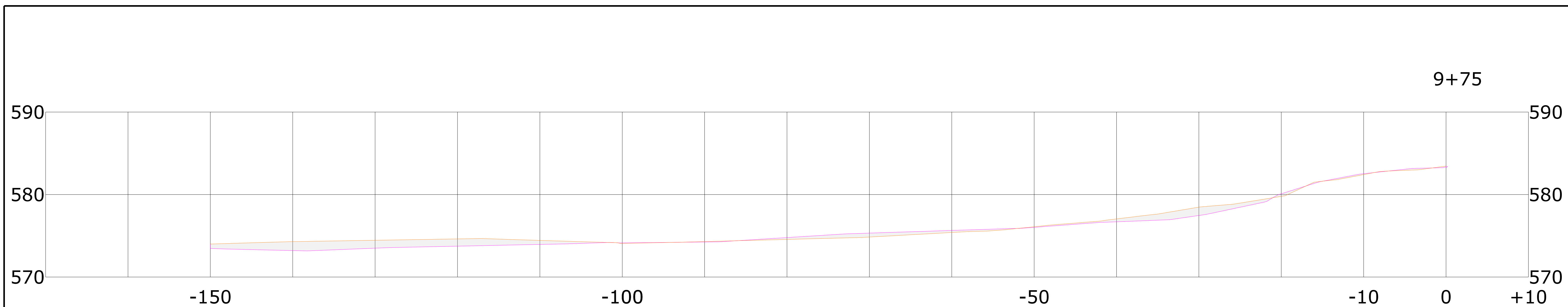
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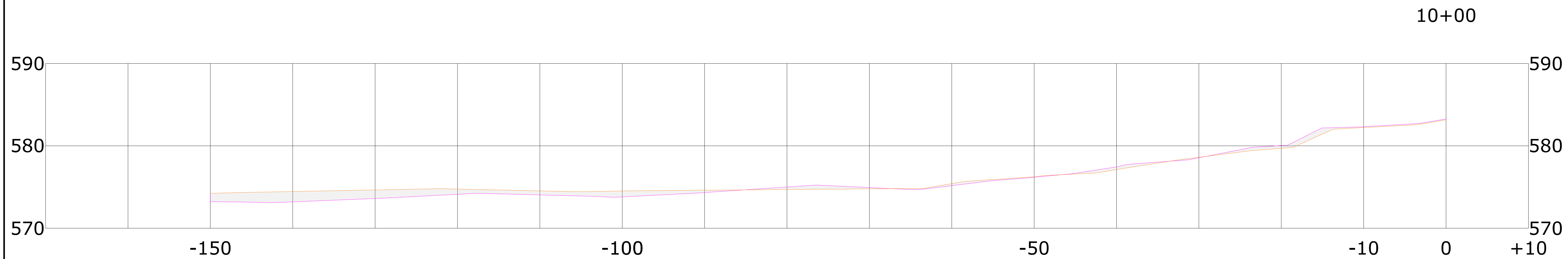
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		END AREA (SQ FT)	VOLUME (CYD)
9+75.00 EX	Excavation	12.0	9
	Fill	52.5	38
10+00.00 EX	Excavation	15.4	13
	Fill	51.9	48



LAKE MICHIGAN

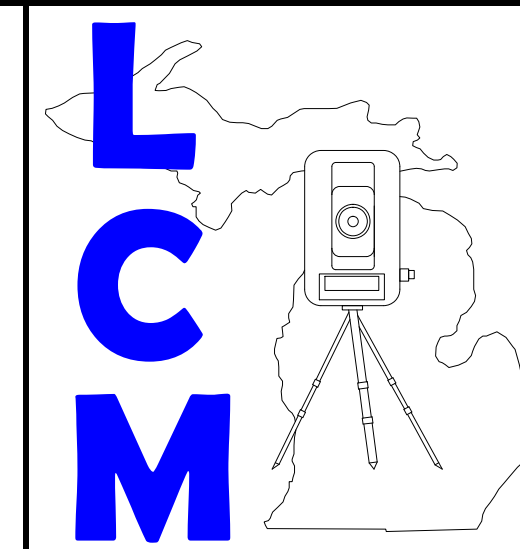
(WATER ELEV:577.9'±, SEPTEMBER 01, 2011)

(WATER ELEV:577.5'±, APRIL 17, 2012)

09-01-2011

04-17-2012

SCALE 1"=6'



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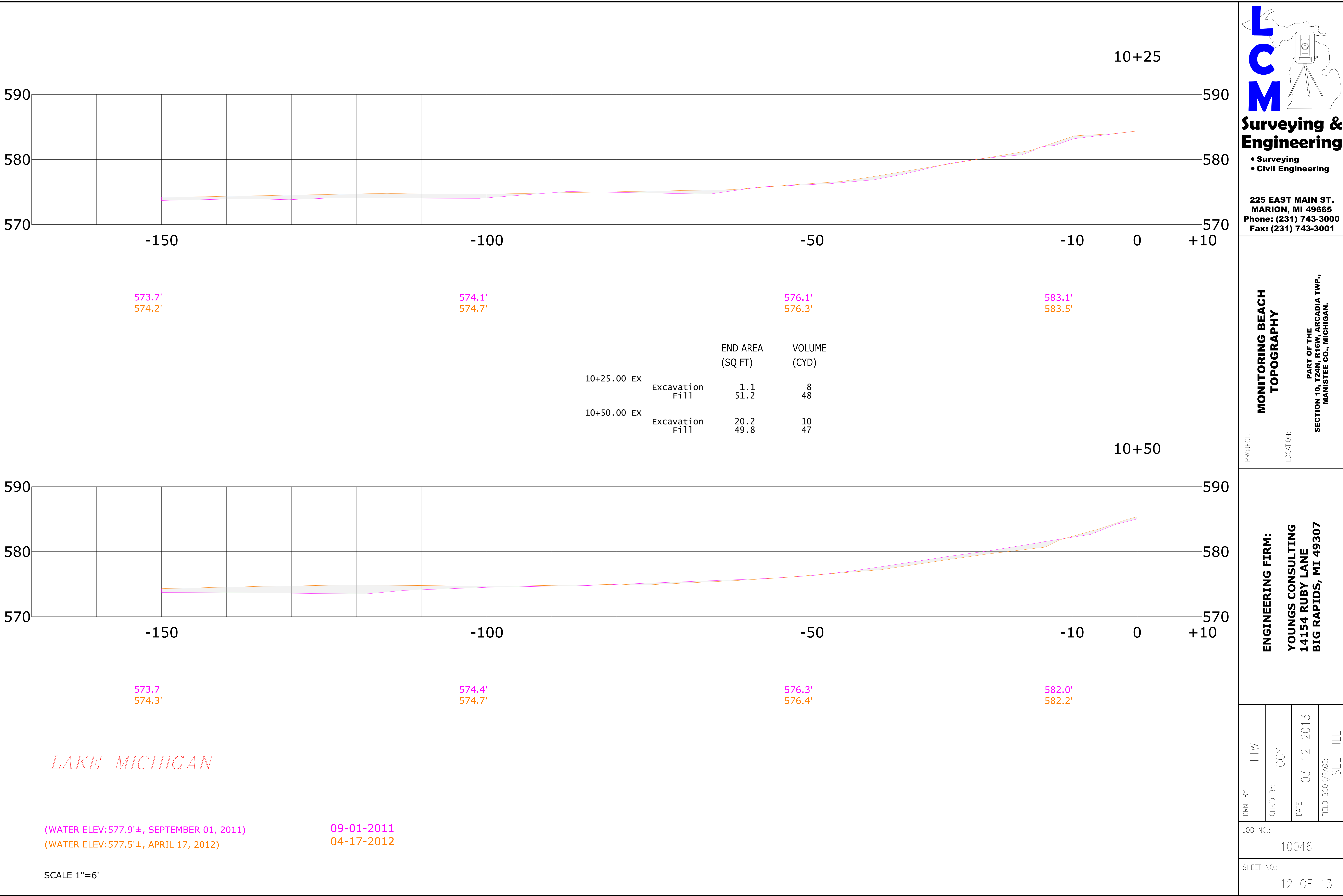
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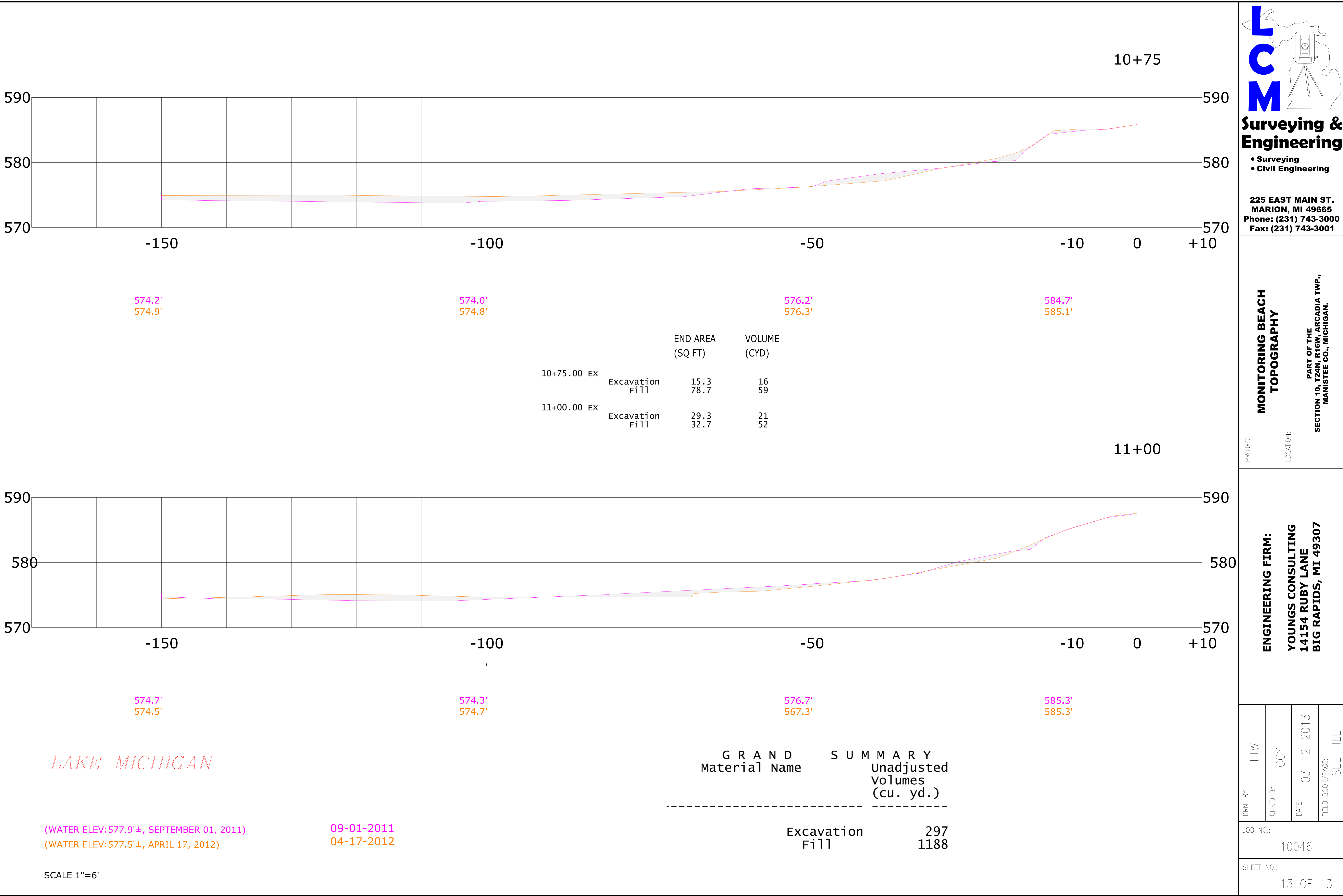
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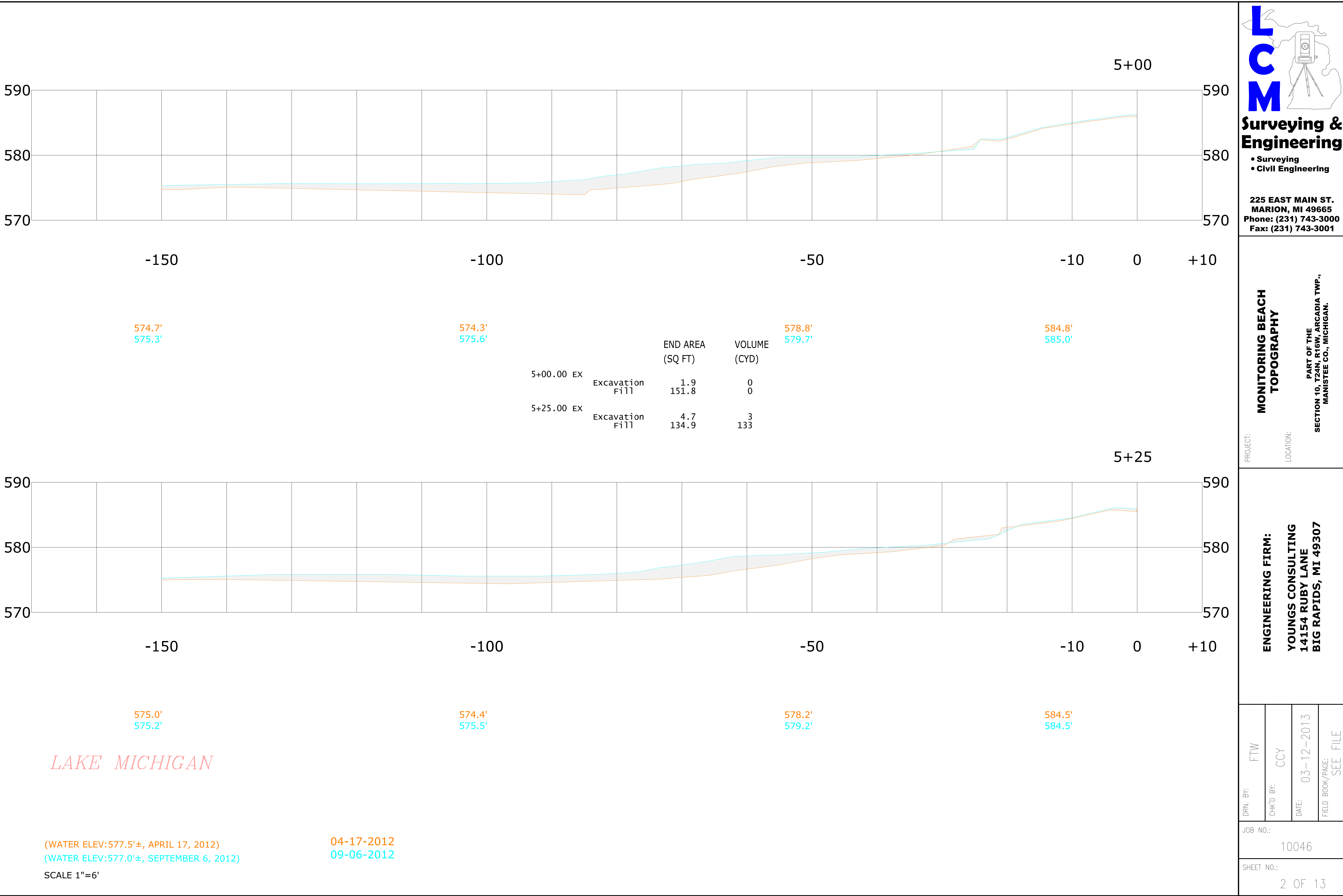
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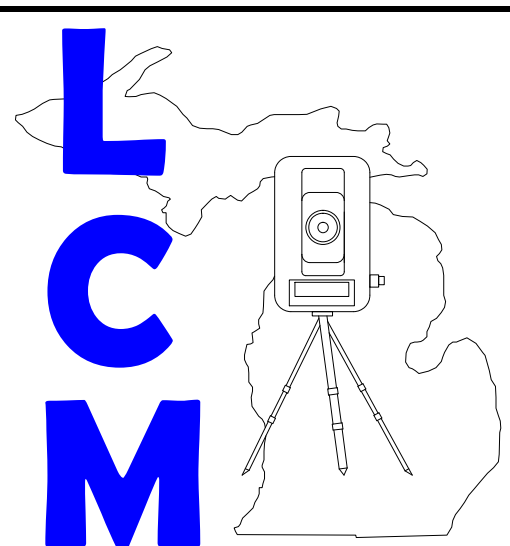
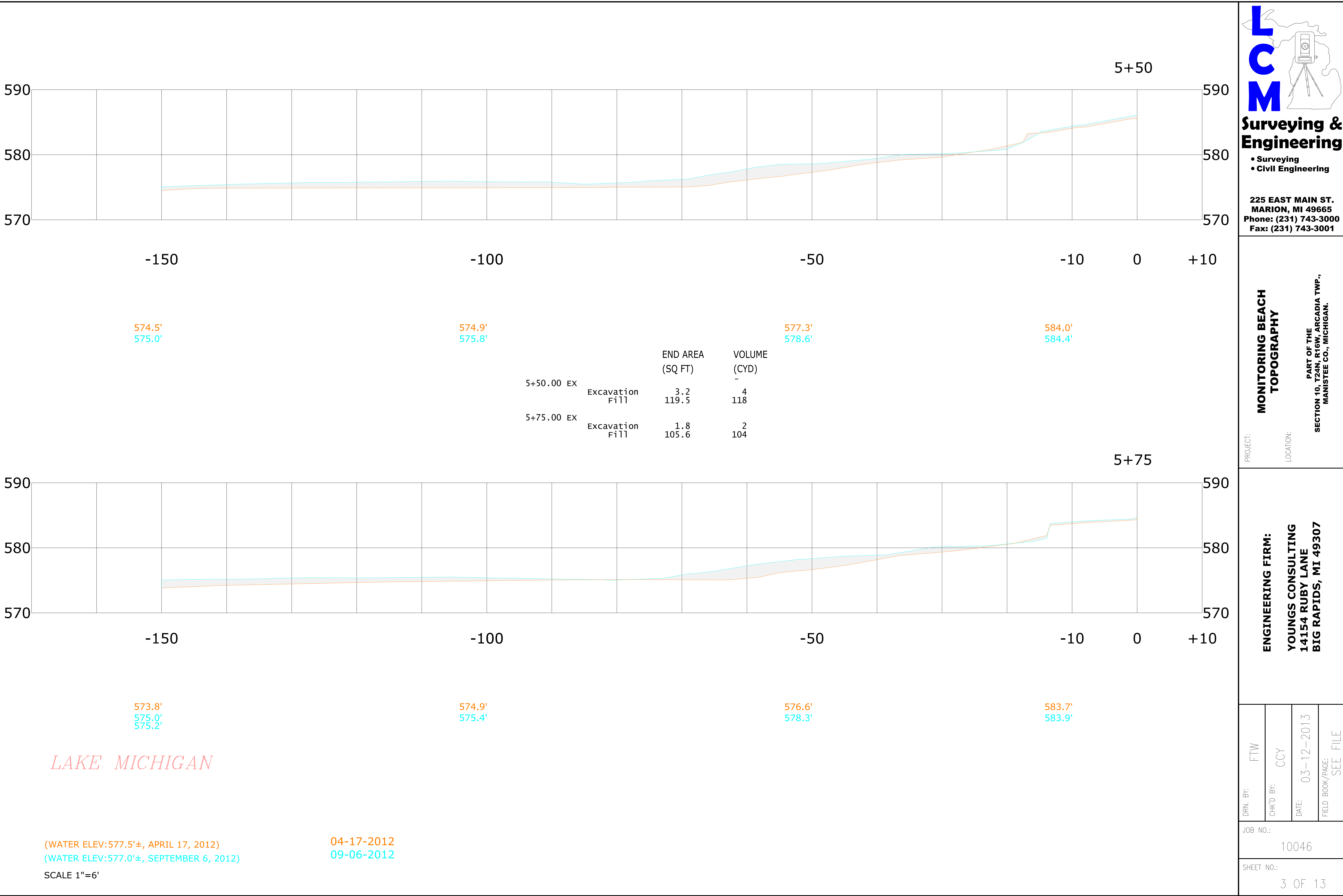
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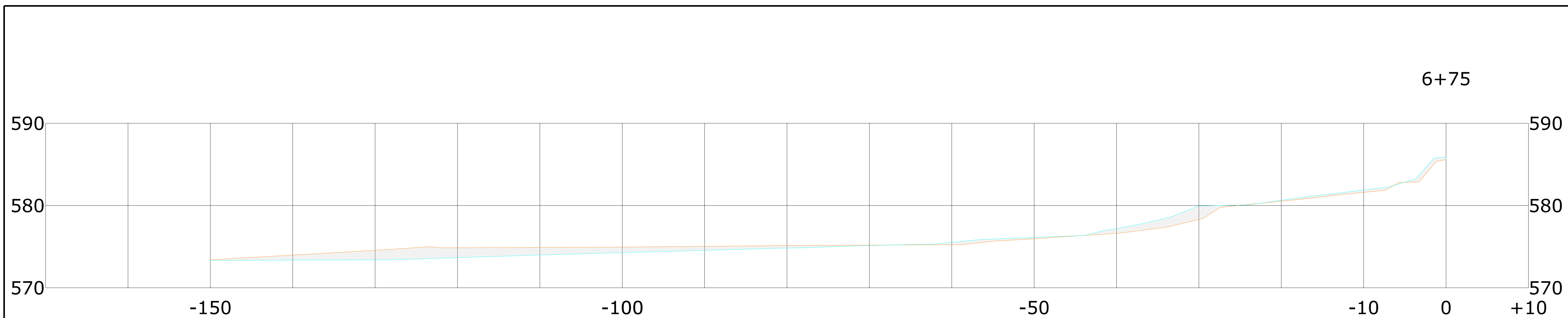
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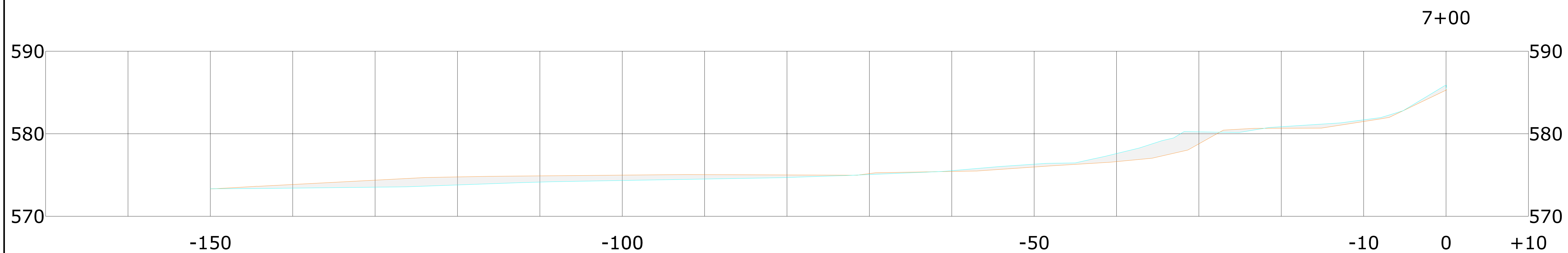
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		END AREA (SQ FT)	VOLUME (CYD)
6+75.00 EX	Excavation	56.2	58
	Fill	24.7	22
7+00.00 EX	Excavation	47.9	48
	Fill	31.8	26



573.3'

573.3'

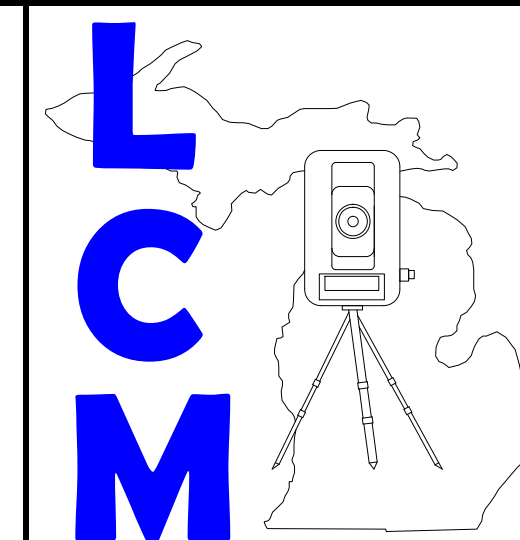
575.2'

LAKE MICHIGAN

(WATER ELEV:577.5'±, APRIL 17, 2012)
(WATER ELEV:577.0'±, SEPTEMBER 6, 2012)

SCALE 1"=6'

04-17-2012
09-06-2012



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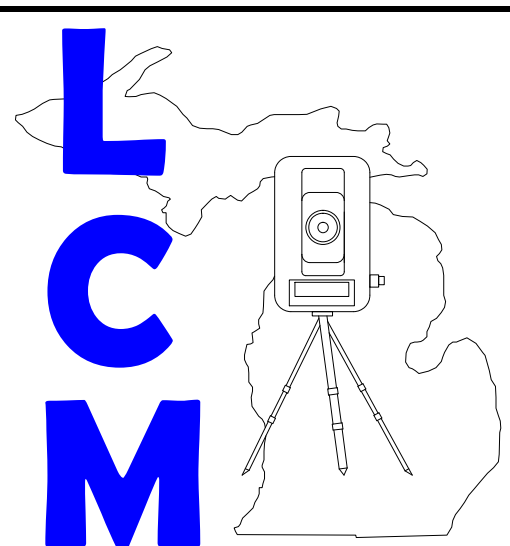
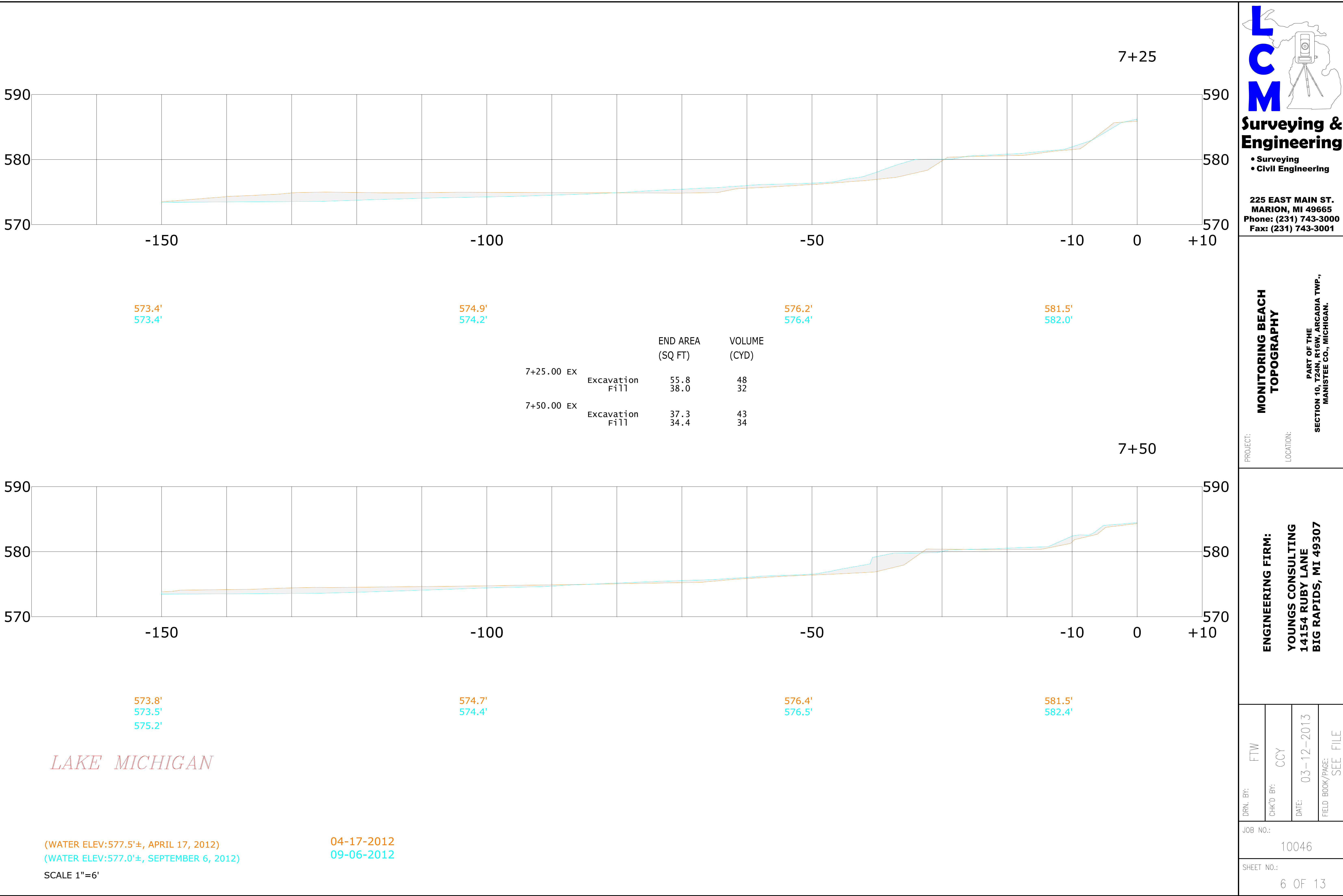
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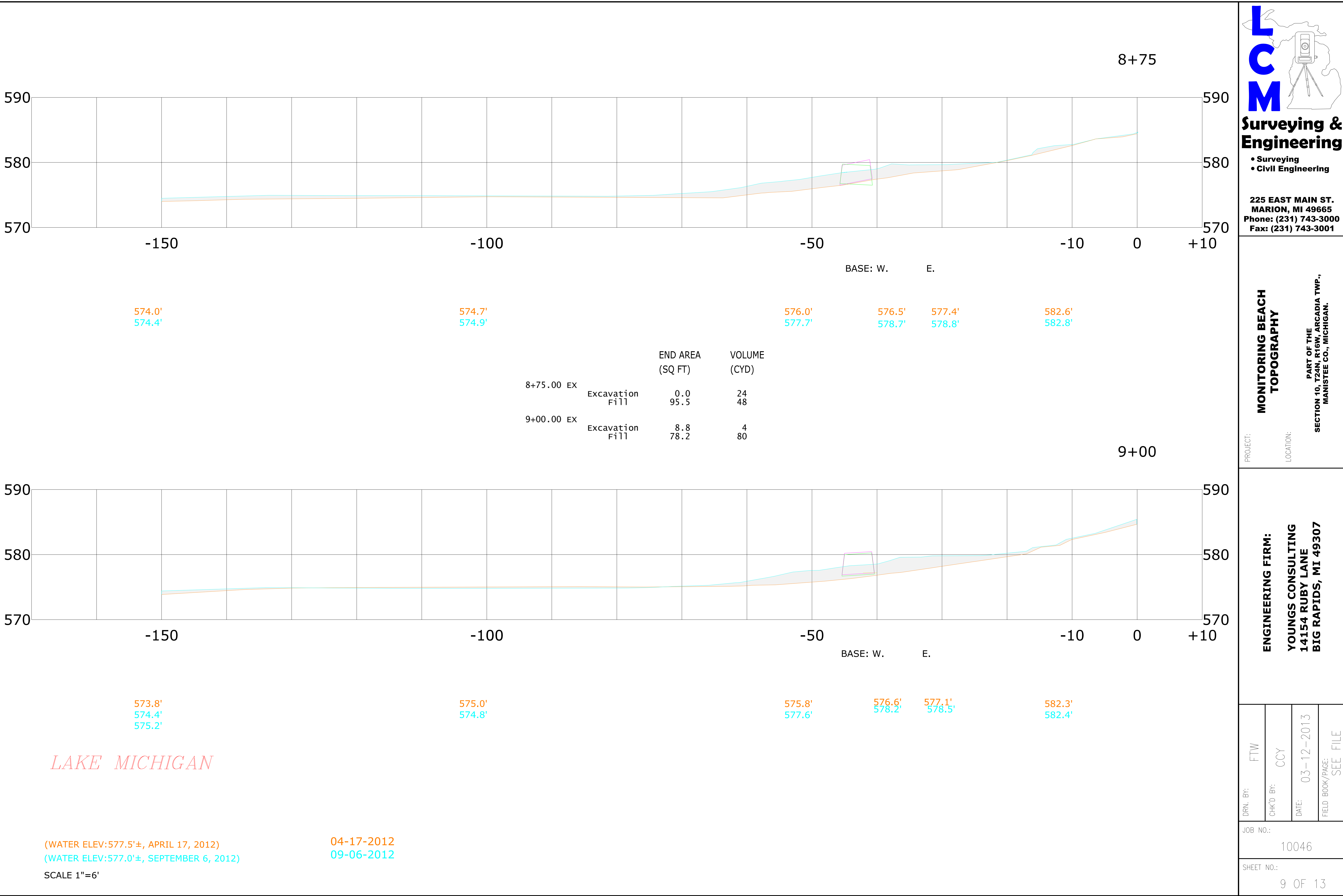
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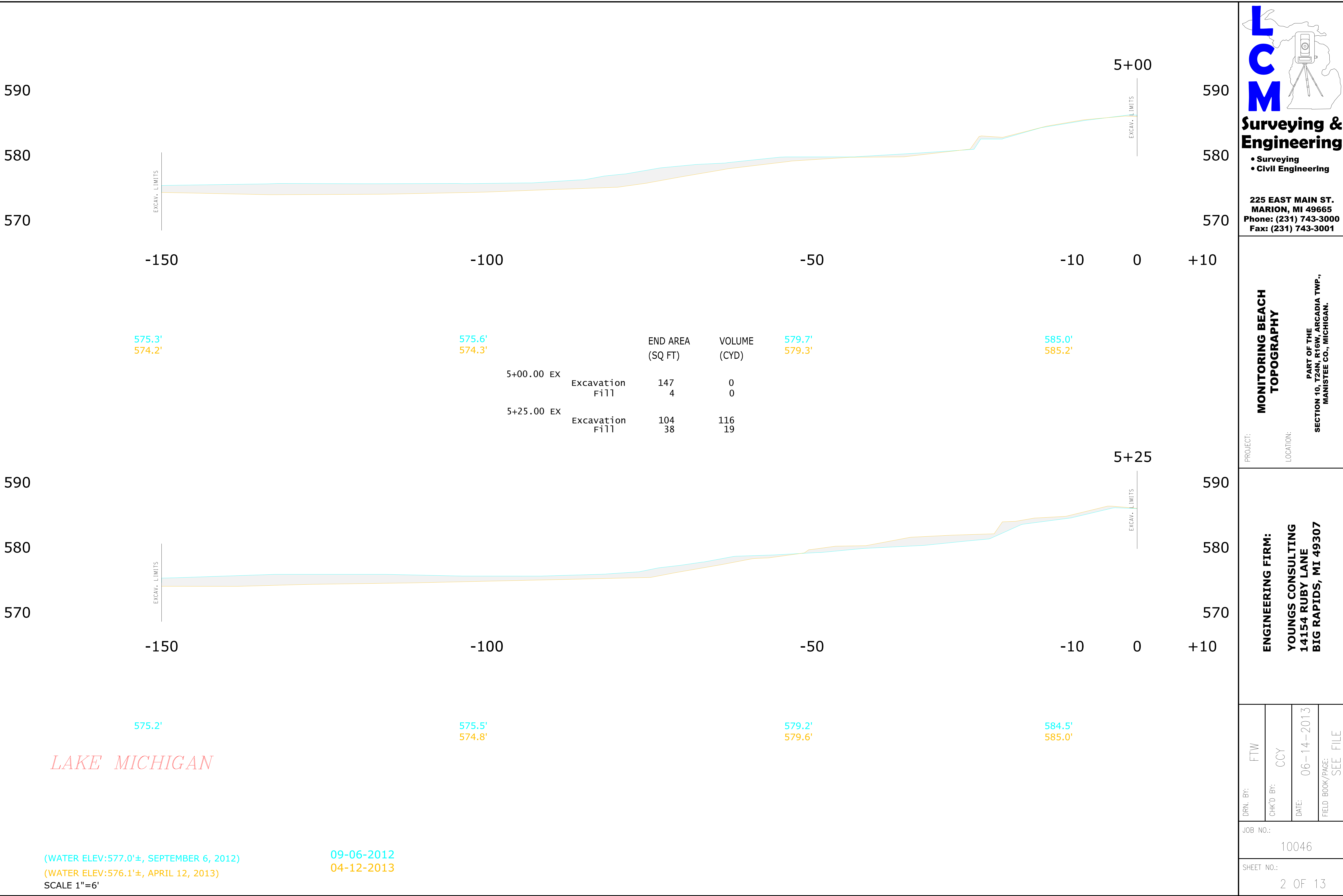
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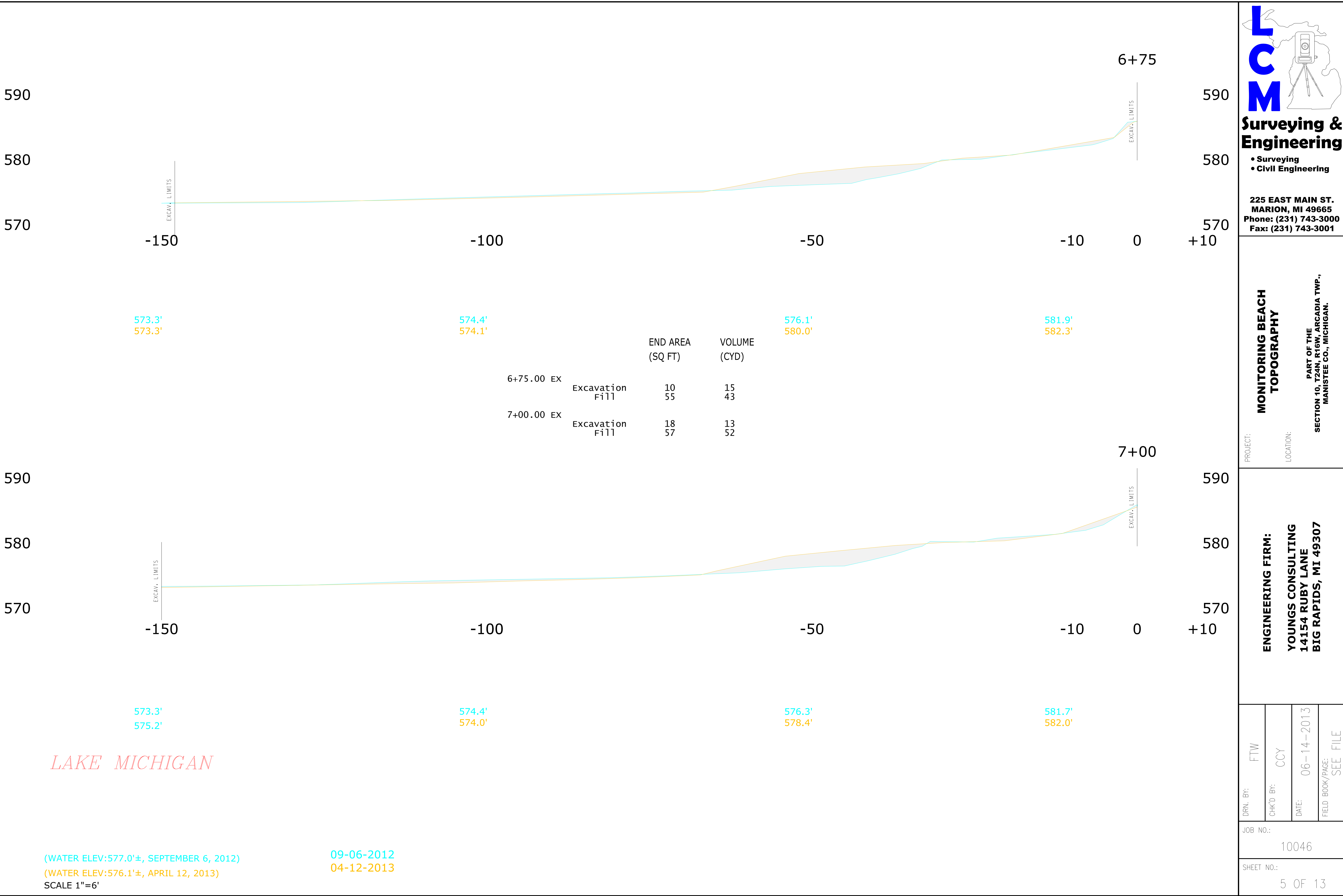
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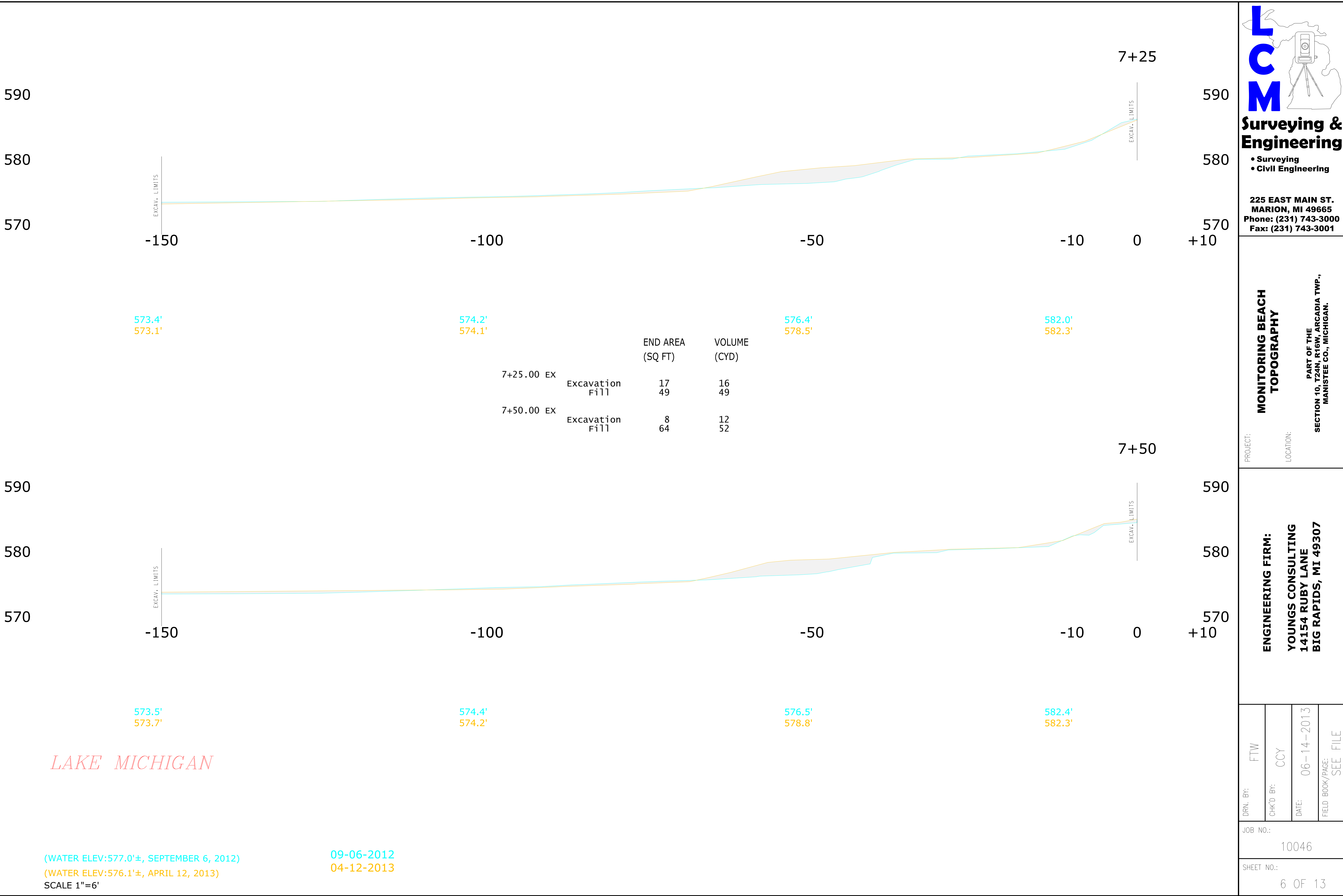
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LAKE MICHIGAN

(WATER ELEV:577.0'±, SEPTEMBER 6, 2012) 09-06-2012
(WATER ELEV:576.1'±, APRIL 12, 2013) 04-12-2013
SCALE 1"=6'



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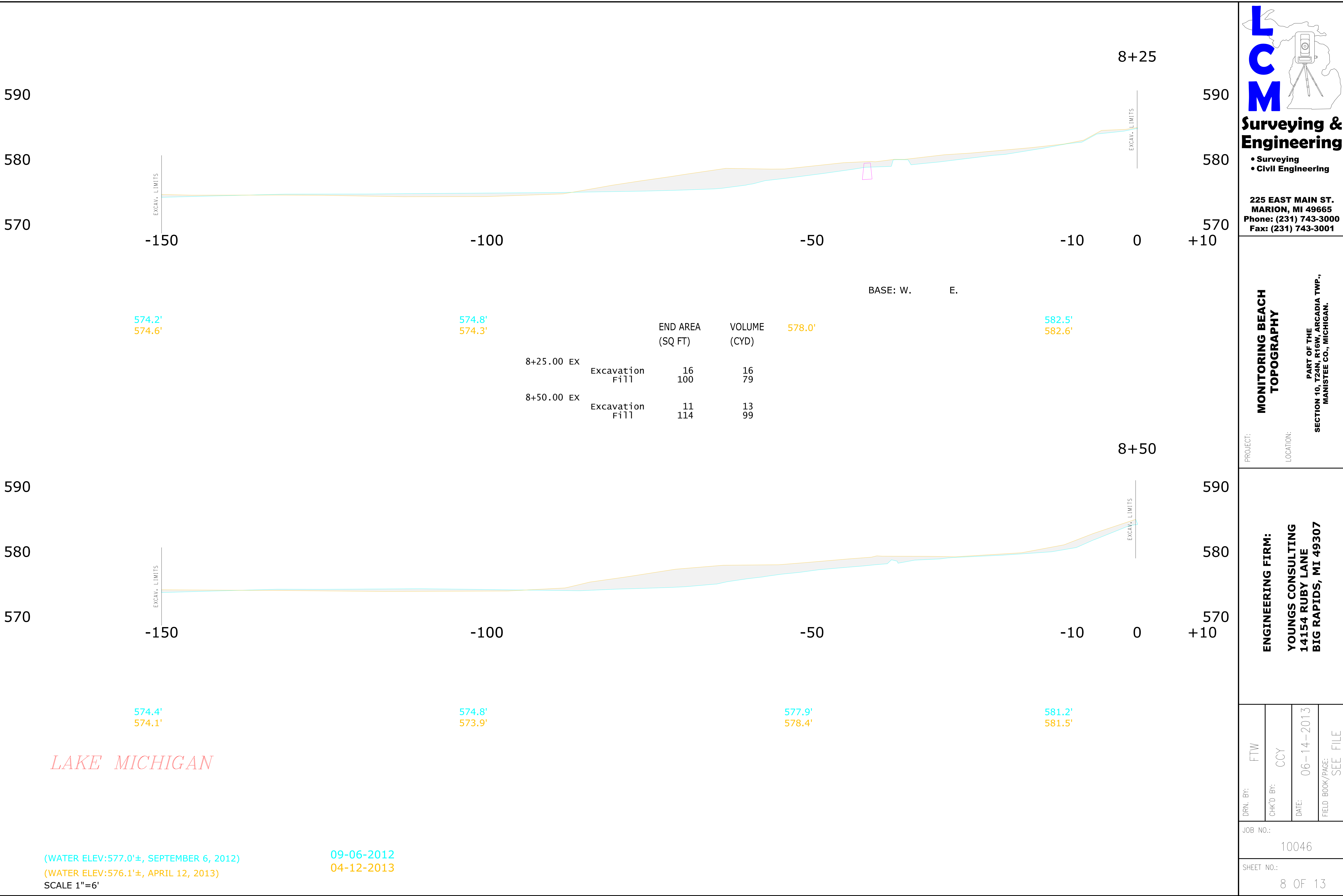
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(WATER ELEV:577.0'±, SEPTEMBER 6, 2012) 09-06-2012
(WATER ELEV:576.1'±, APRIL 12, 2013) 04-12-2013
SCALE 1"=6'



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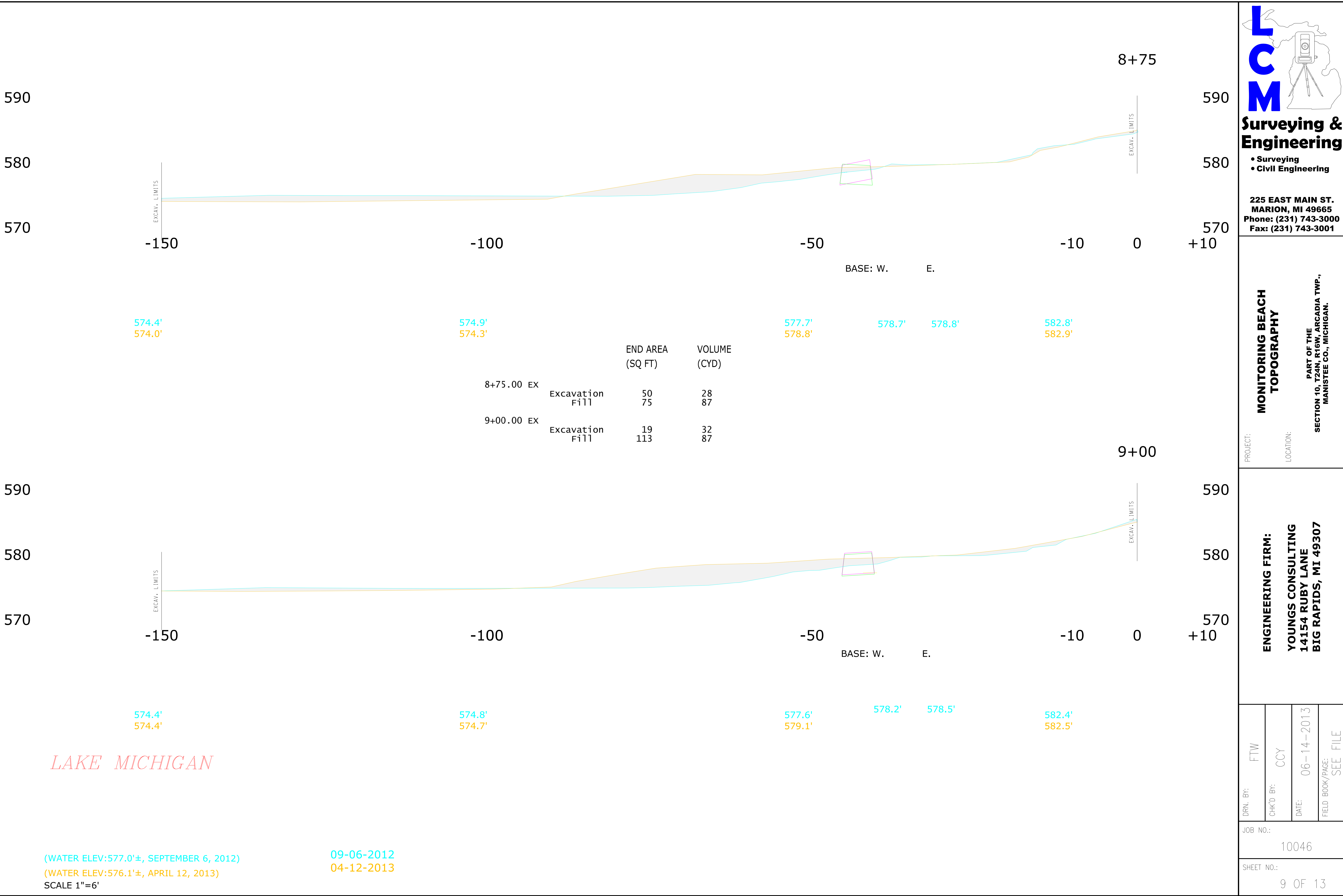
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(WATER ELEV:577.0'±, SEPTEMBER 6, 2012) 09-06-2012
(WATER ELEV:576.1'±, APRIL 12, 2013) 04-12-2013
SCALE 1"=6'



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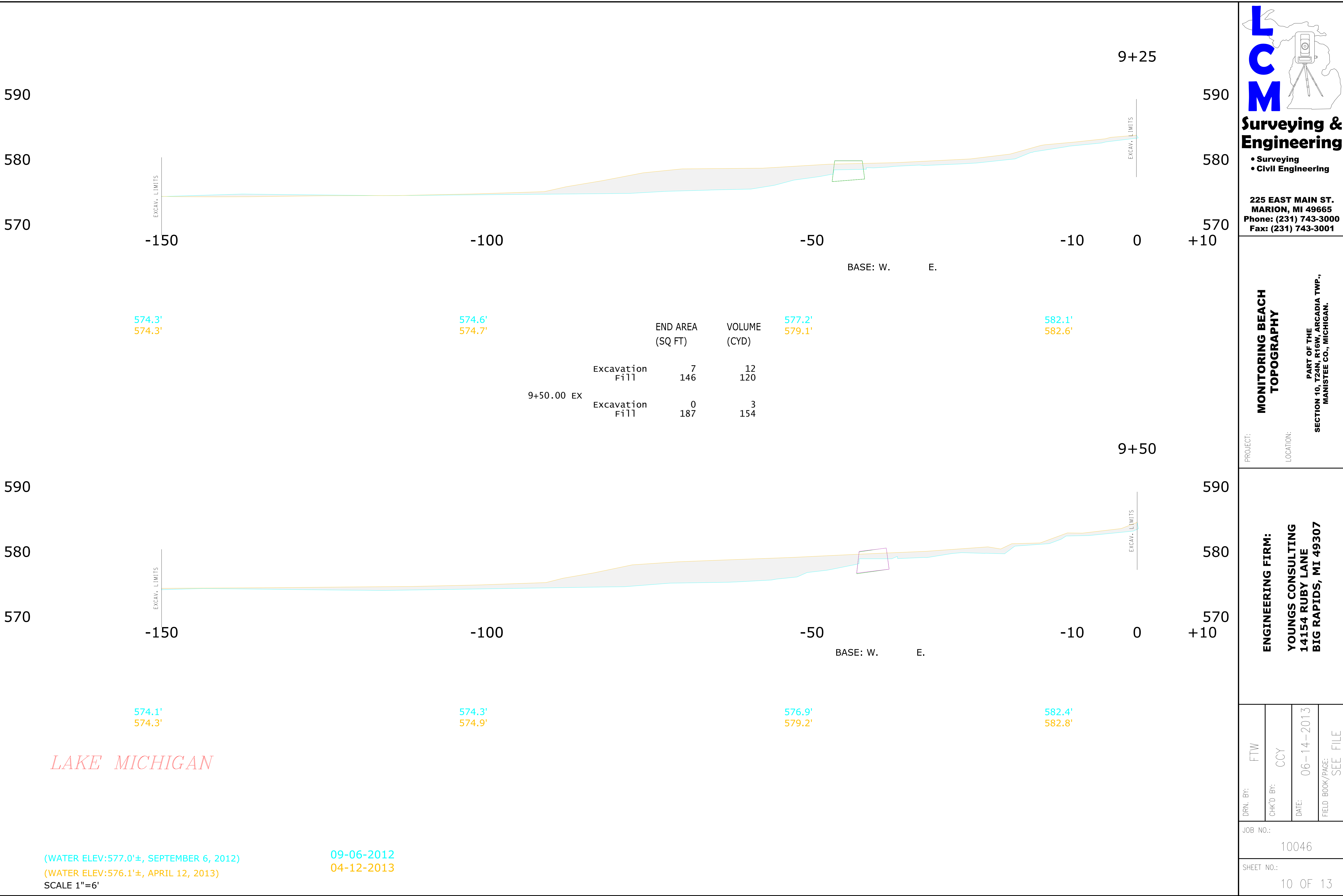
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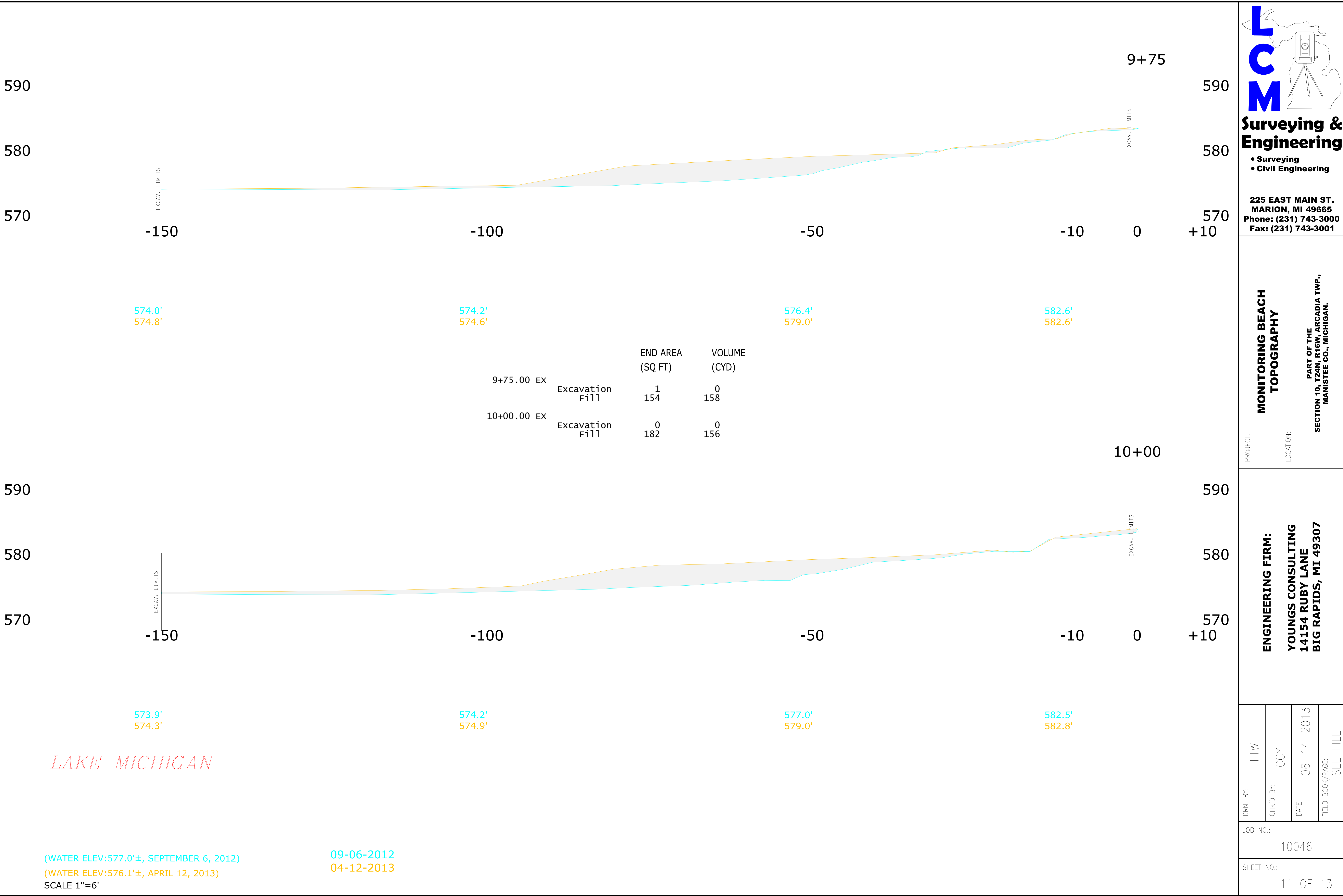
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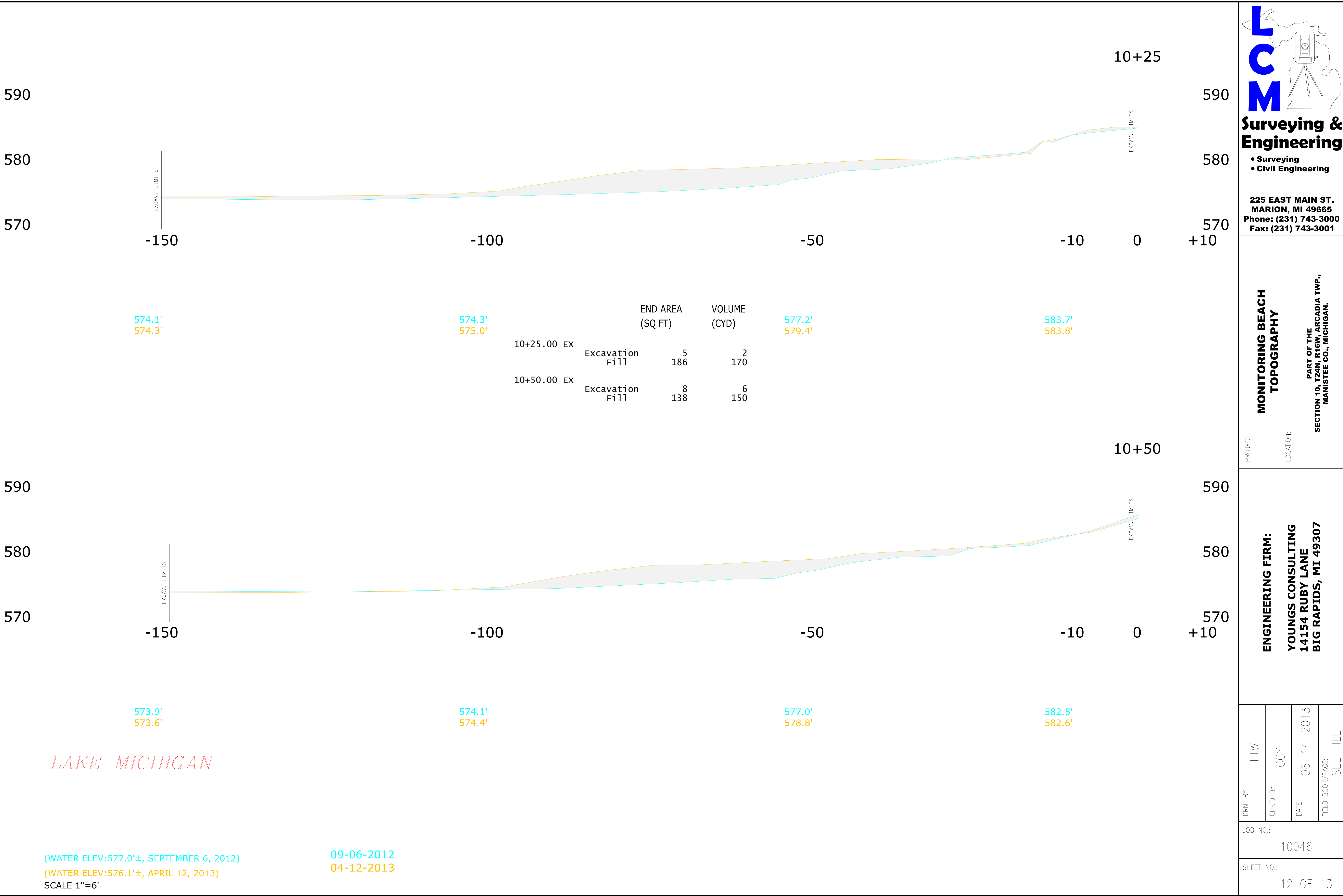
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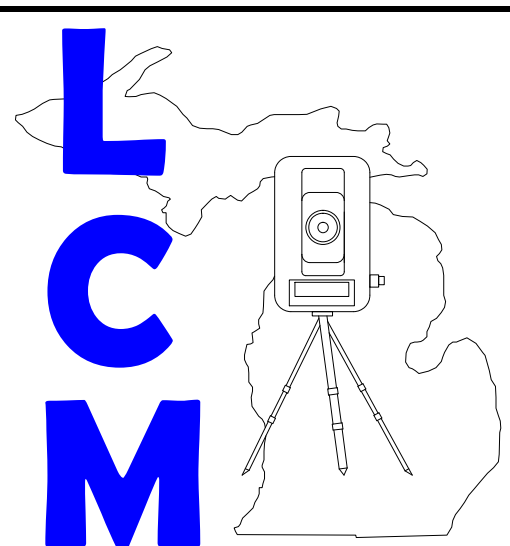
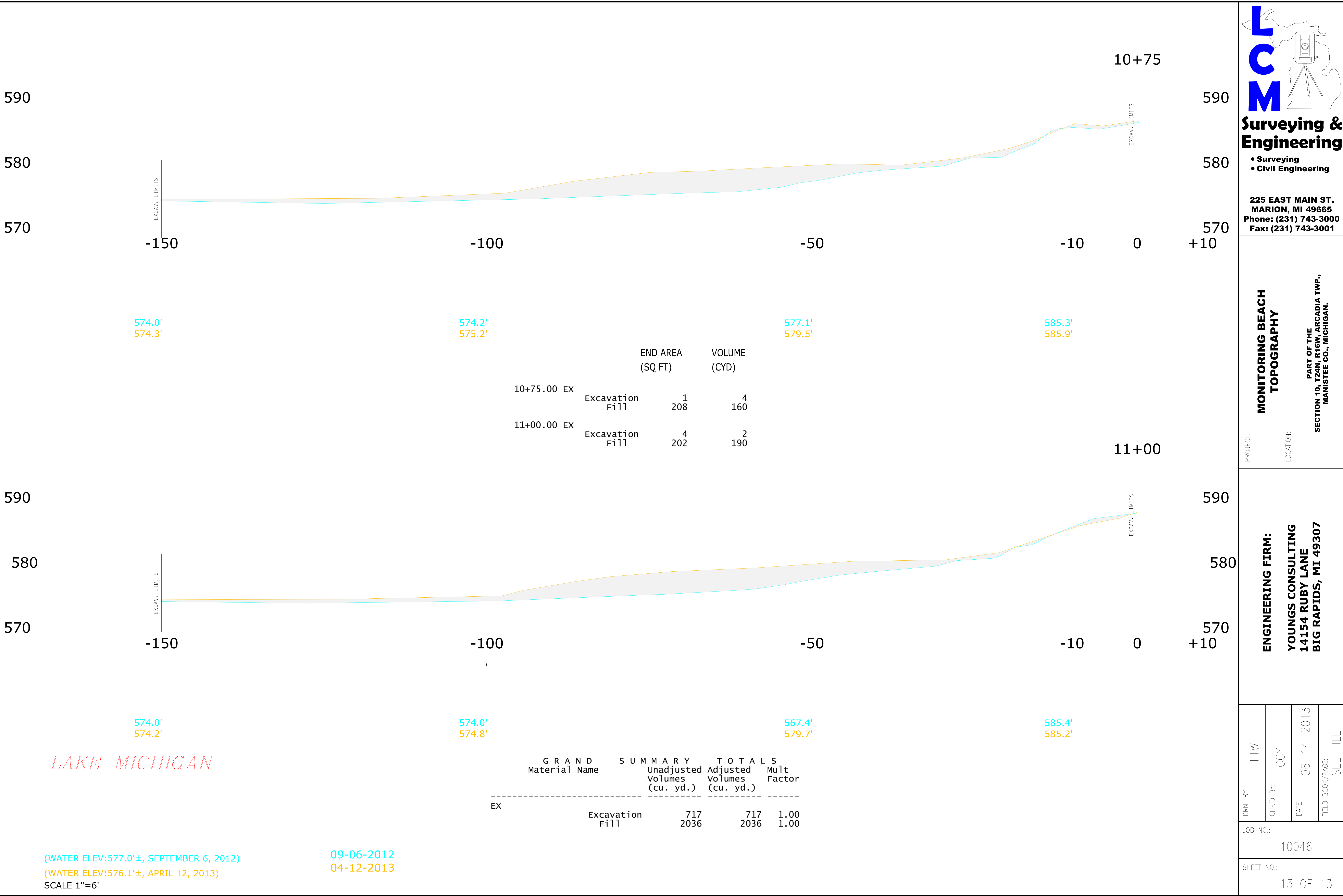
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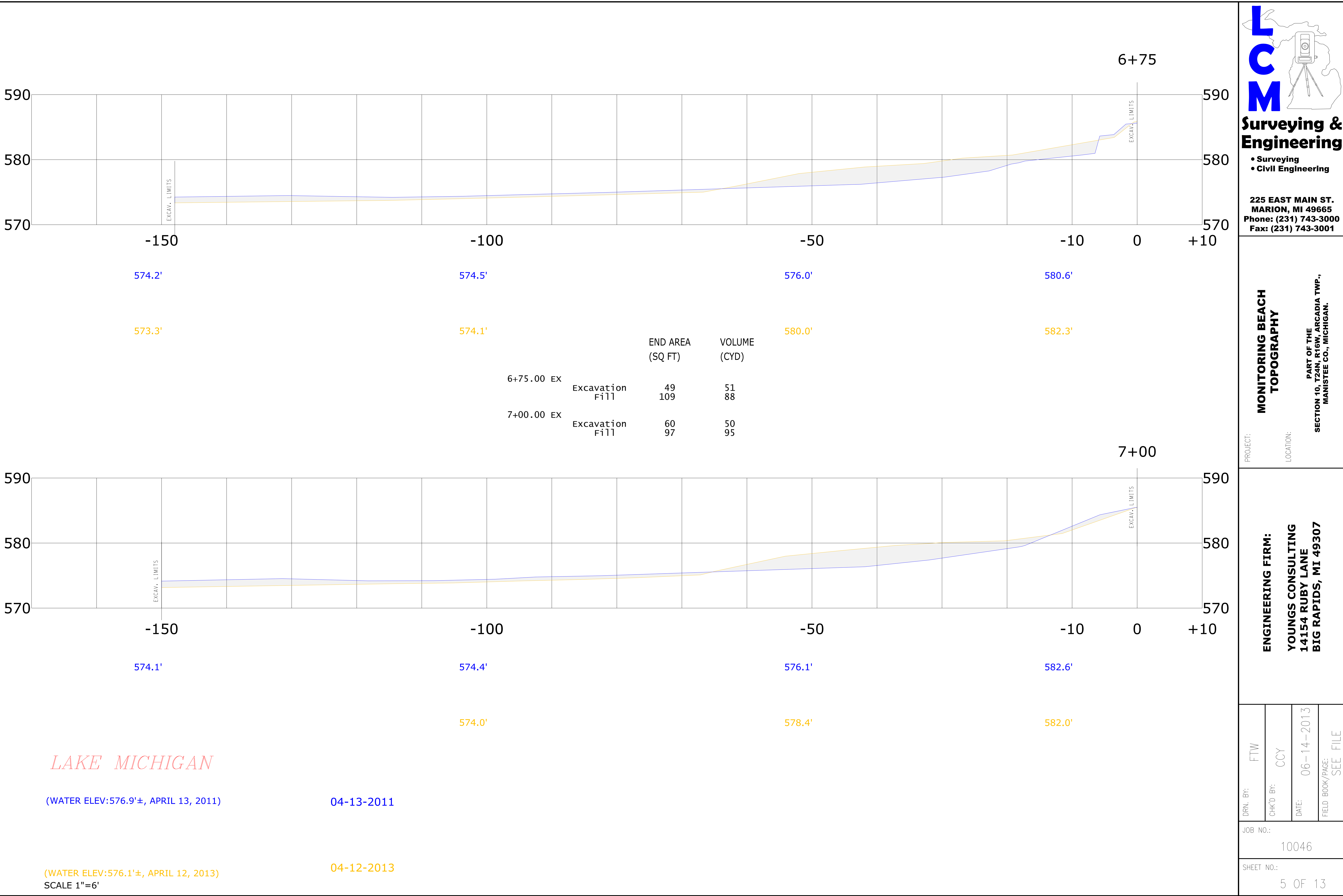
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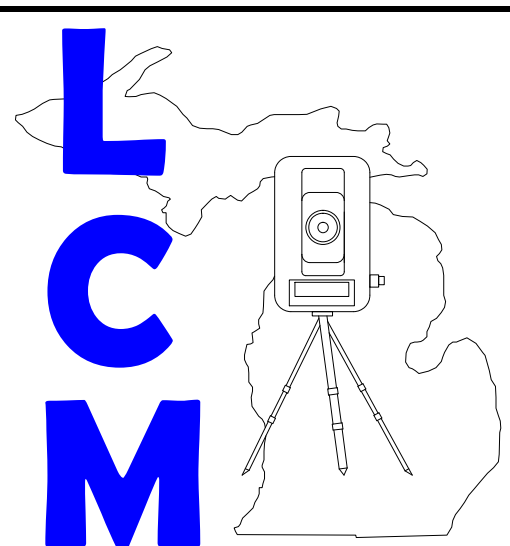
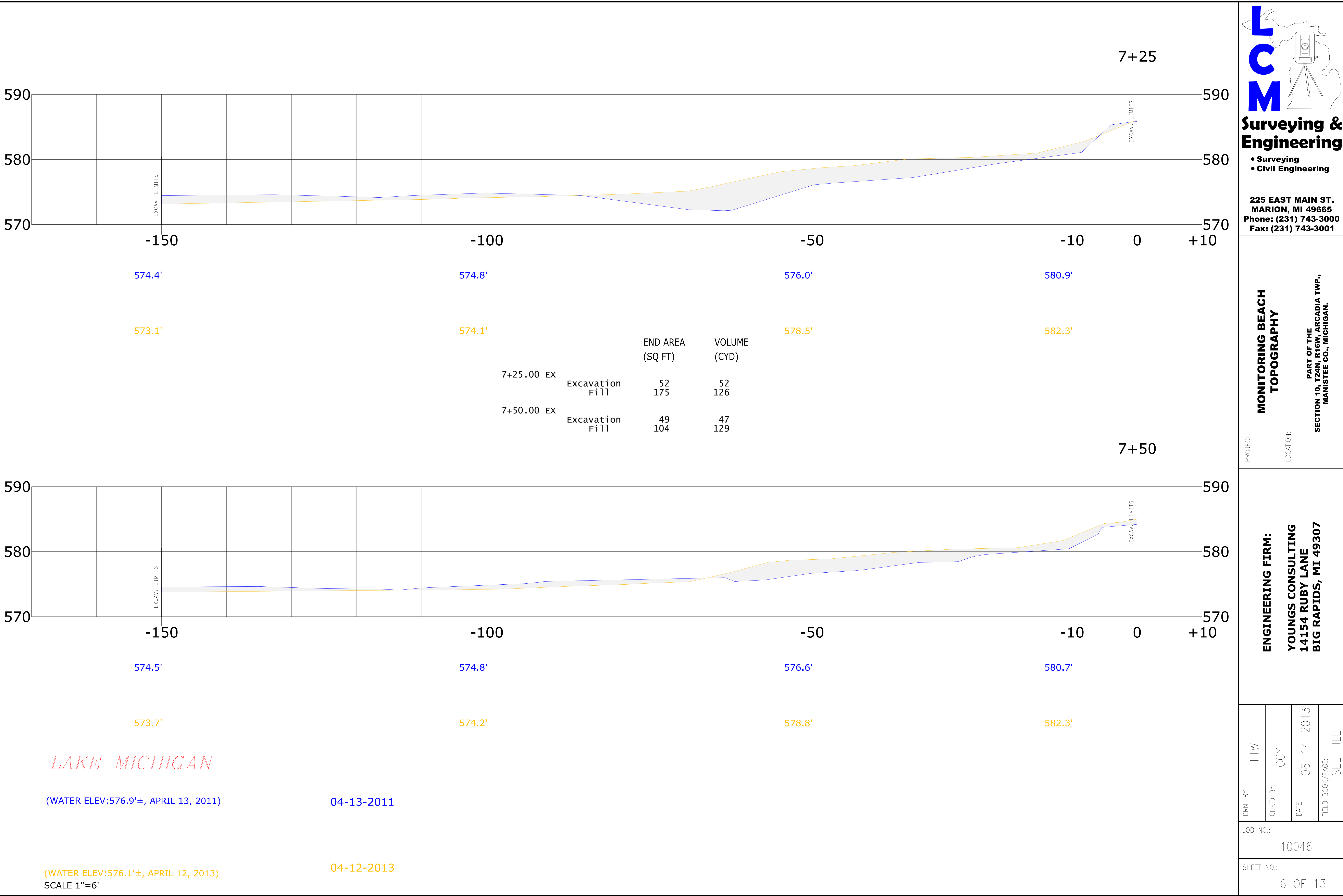
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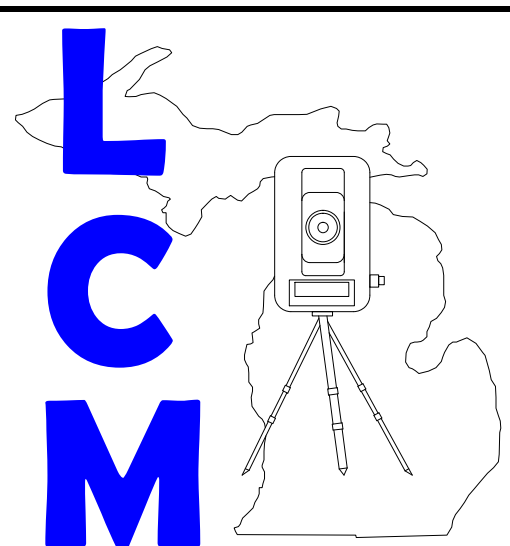
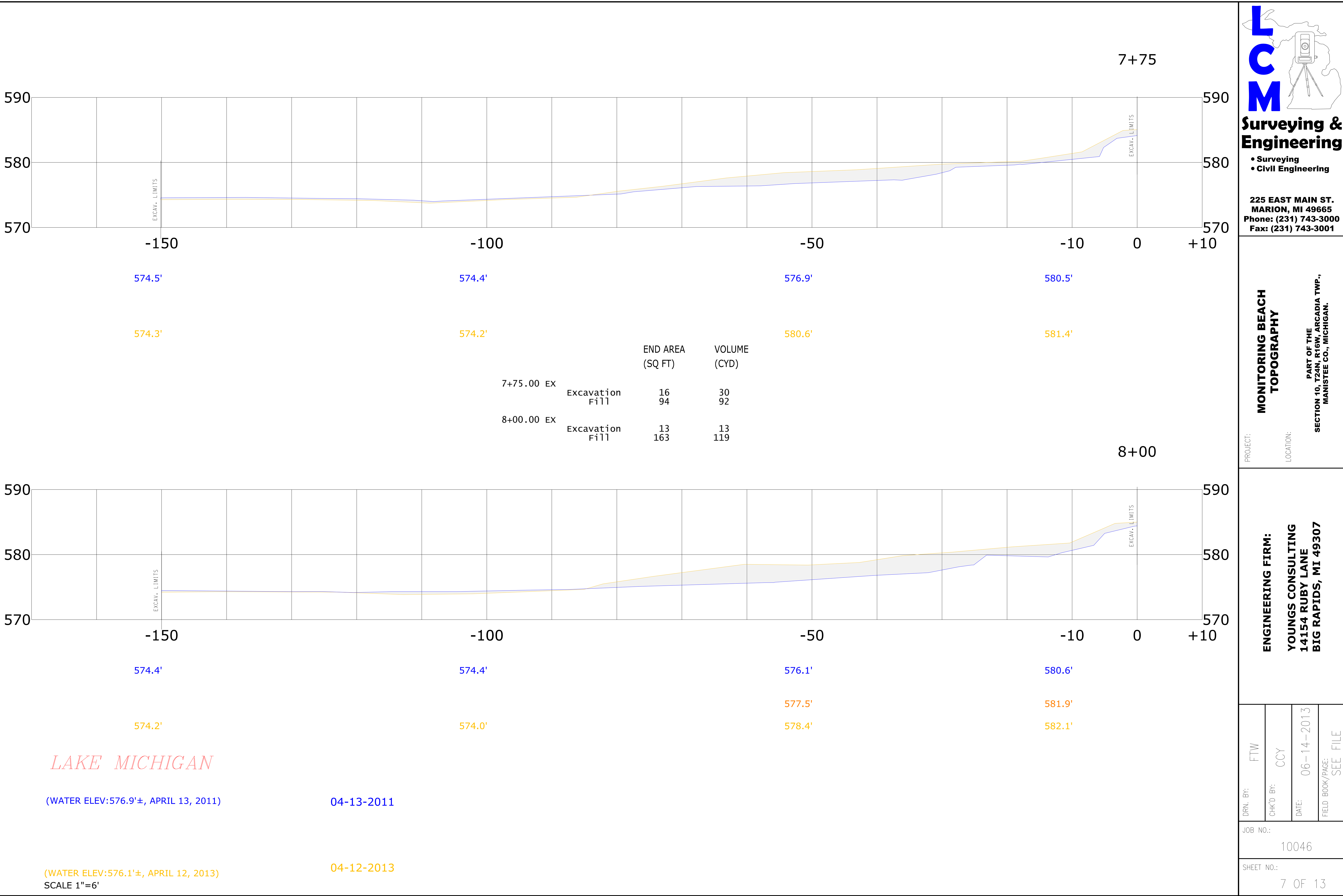
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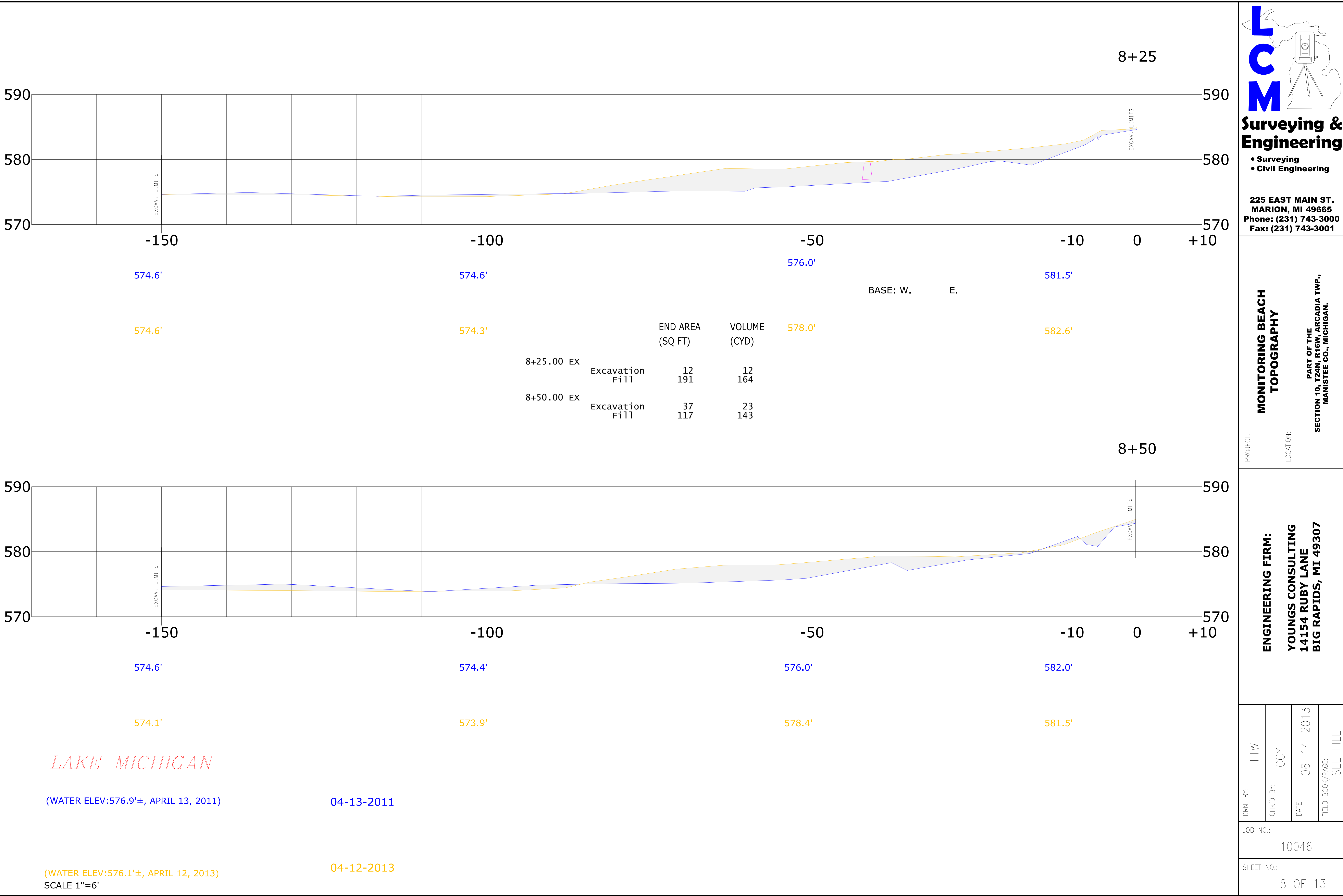
LAKE MICHIGAN

(WATER ELEV:576.9'±, APRIL 13, 2011)

04-13-2011

(WATER ELEV:576.1'±, APRIL 12, 2013)
SCALE 1"=6'

04-12-2013



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PROJECT:

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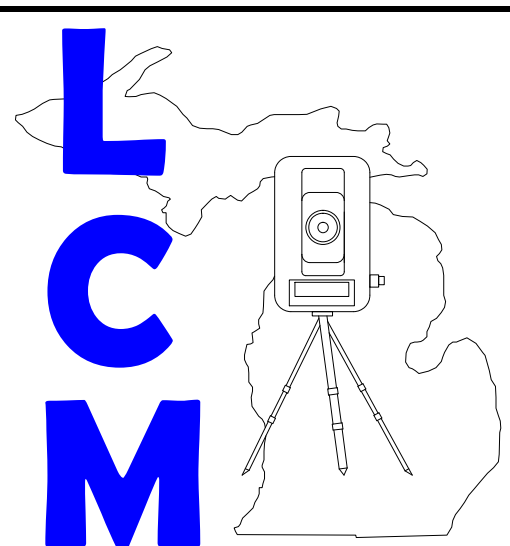
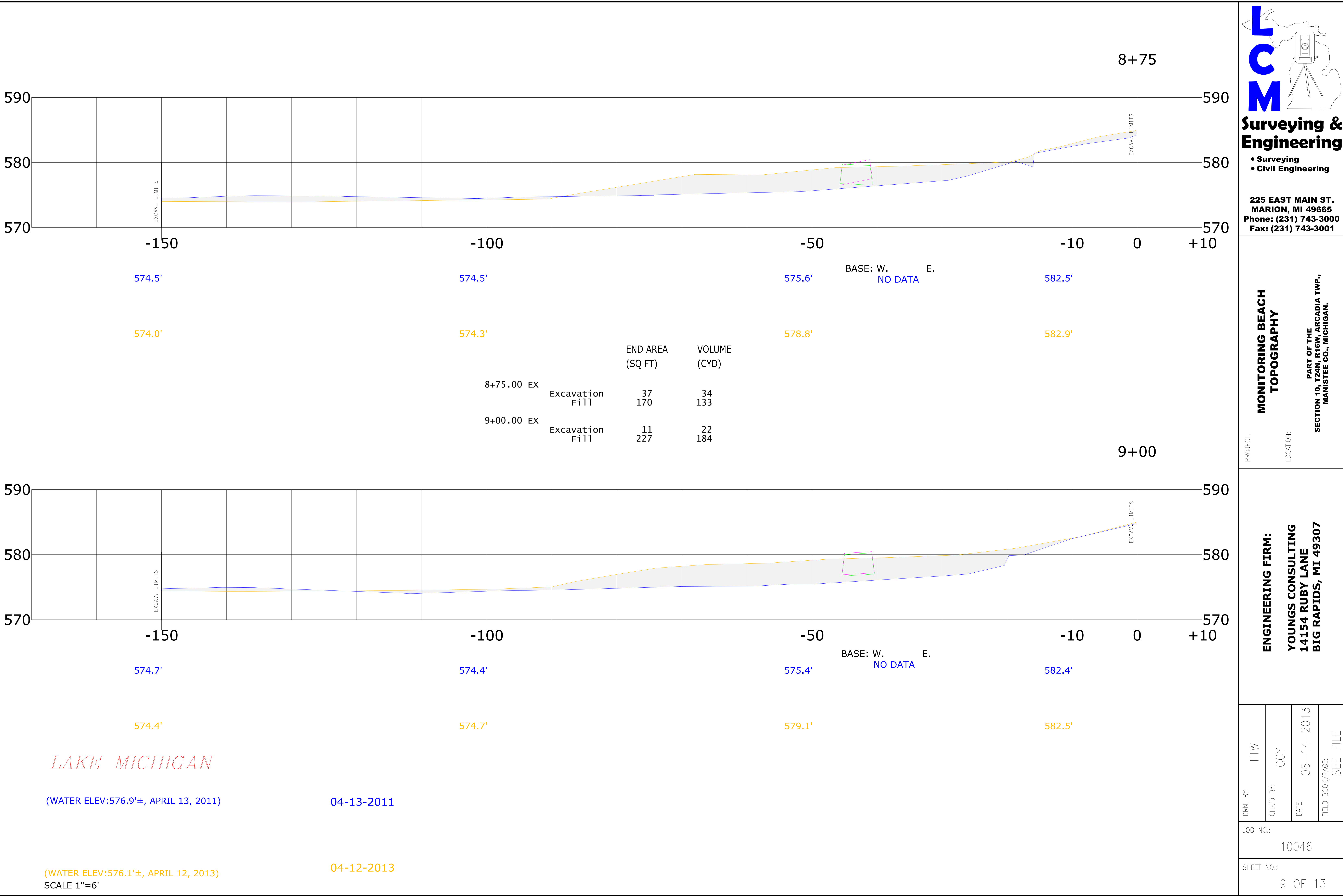
PART OF THE
SECTION 10, T24N, R16W, ARCADIA TWP.,
MANISTEE CO., MICHIGAN.

ENGINEERING FIRM:

**YOUNGS CONSULTING
14154 RUBY LANE
BIG RAPIDS, MI 49307**

DRN. BY:	FTW
CHK'D BY:	CCY
DATE:	06-14-2013
FIELD BOOK/PAGE:	SEE FILE

JOB NO.:	10046
SHEET NO.:	8 OF 13



Surveying & Engineering

- Surveying
- Civil Engineering

225 EAST MAIN ST.
MARION, MI 49665
Phone: (231) 743-3000
Fax: (231) 743-3001

**MONITORING BEACH
TOPOGRAPHY**

PROJECT:

LOCATION:

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JOB NO.:
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SHEET NO.:
9 OF 13

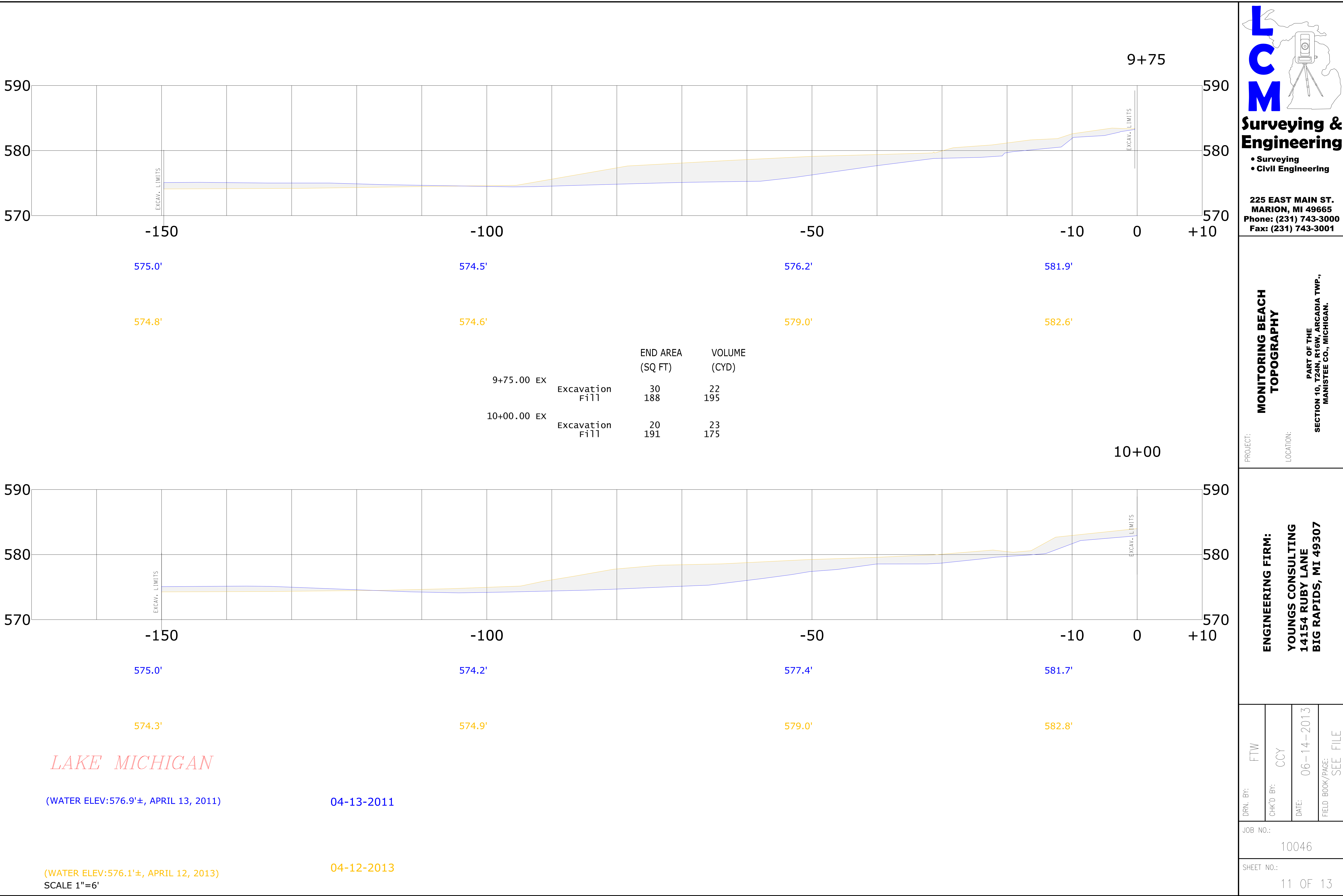
LAKE MICHIGAN

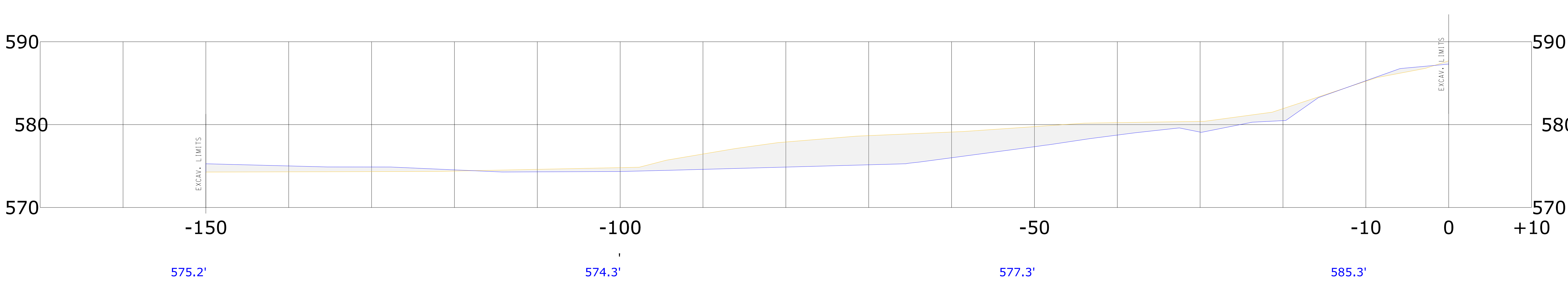
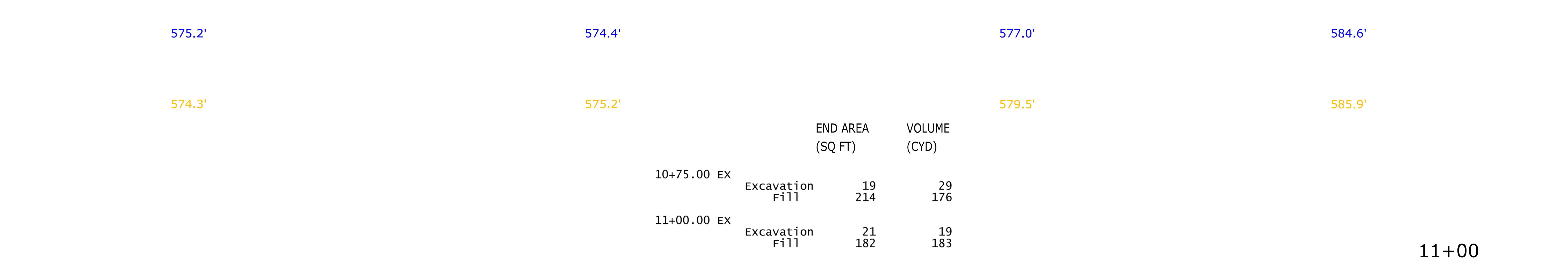
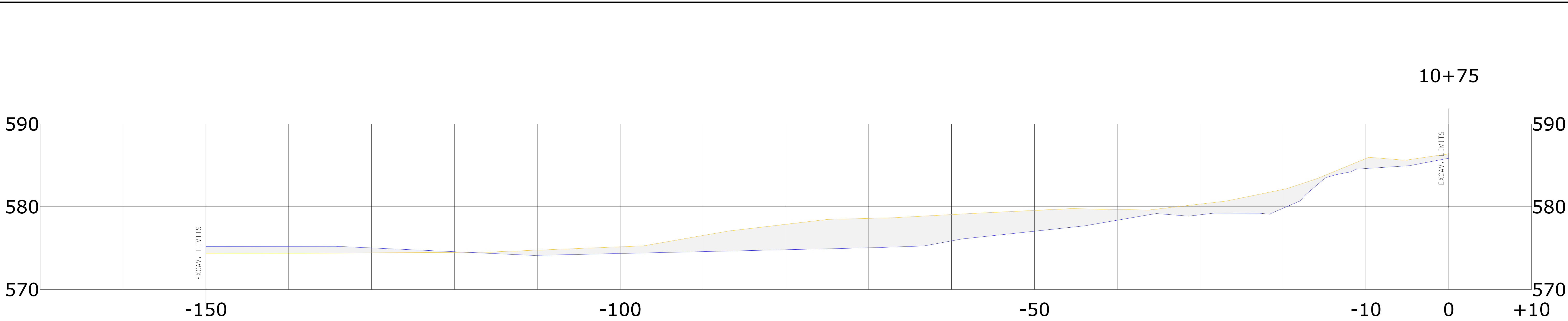
(WATER ELEV:576.9'±, APRIL 13, 2011)

04-13-2011

(WATER ELEV:576.1'±, APRIL 12, 2013)
SCALE 1"=6'

04-12-2013





LAKE MICHIGAN

(WATER ELEV:576.9'±, APRIL 13, 2011)

04-13-2011

(WATER ELEV:576.1'±, APRIL 12, 2013)
SCALE 1"=6'

04-12-2013

G R A N D		S U M M A R Y		T O T A L S	
Material Name		Unadjusted Volumes (cu. yd.)	Adjusted Volumes (cu. yd.)	Mult Factor	
EX					
Excavation Fill		753	753	1.00	1.00

LCM

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MONITORING BEACH TOPOGRAPHY

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