<><> Time Stamp <><>

Code started: 05/10/2022 - 14:57:56
Total Run Time: 9.628 s

<><> Bore Information <><>

Bore ID: GW036872.1.1
Region: Coastal
Bore Coordinates: (-30.923963, 153.044423)
Agency: WaterNSW
Drilled Date: 01/08/1990
Bore Depth: 30.5 m
Drilled Depth: 30.5 m
Reference Elevation: nan m
Time Series Reference Elevation: nan m
Land Surface Elevation: nan m
Silo Grid Point Coordinates: (-30.9, 153.05)

<><> Model Output <><>

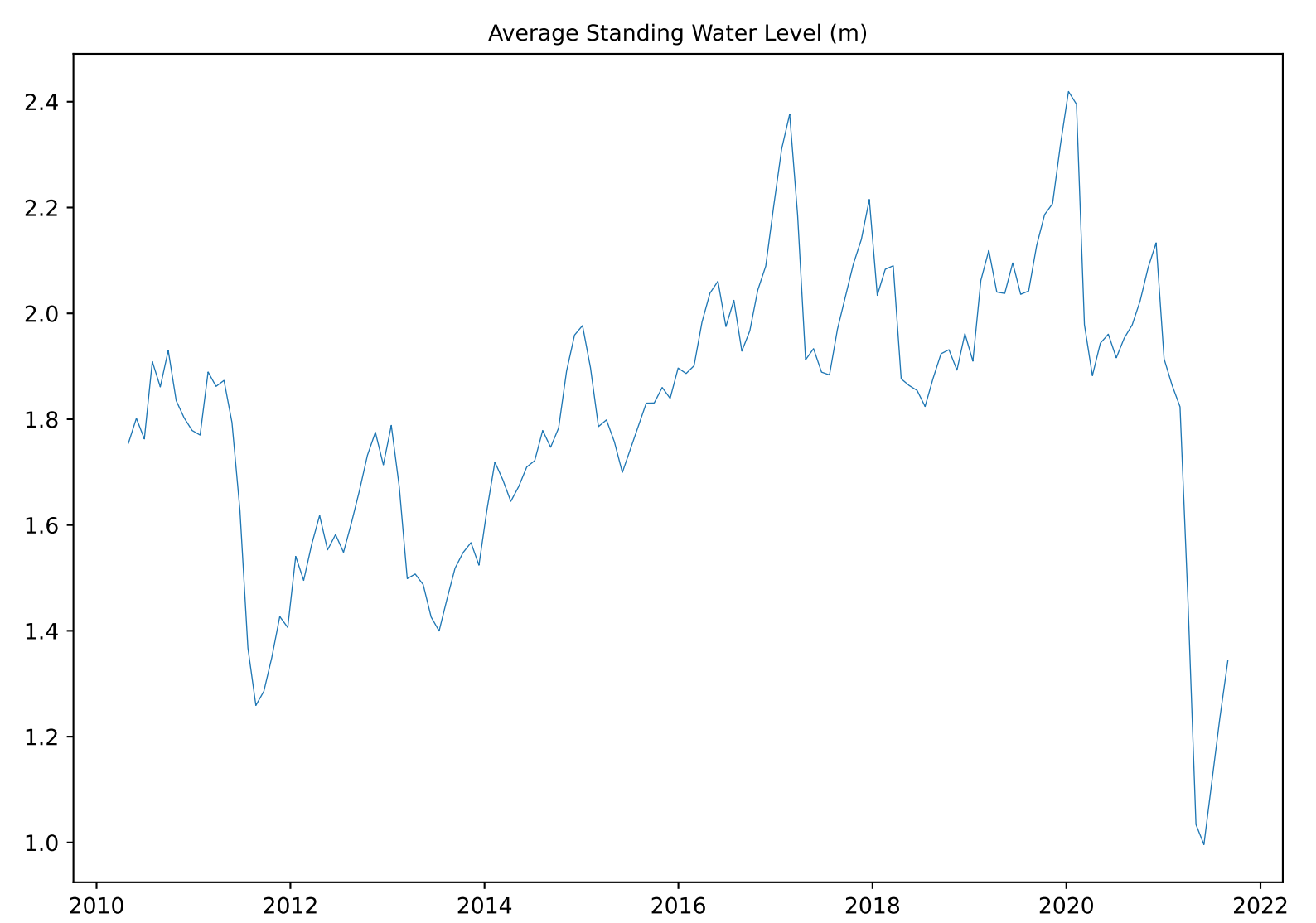
Averaged Period: 30 day(s)
Output: Average Standing Water Level (m) in 1 period(s) time

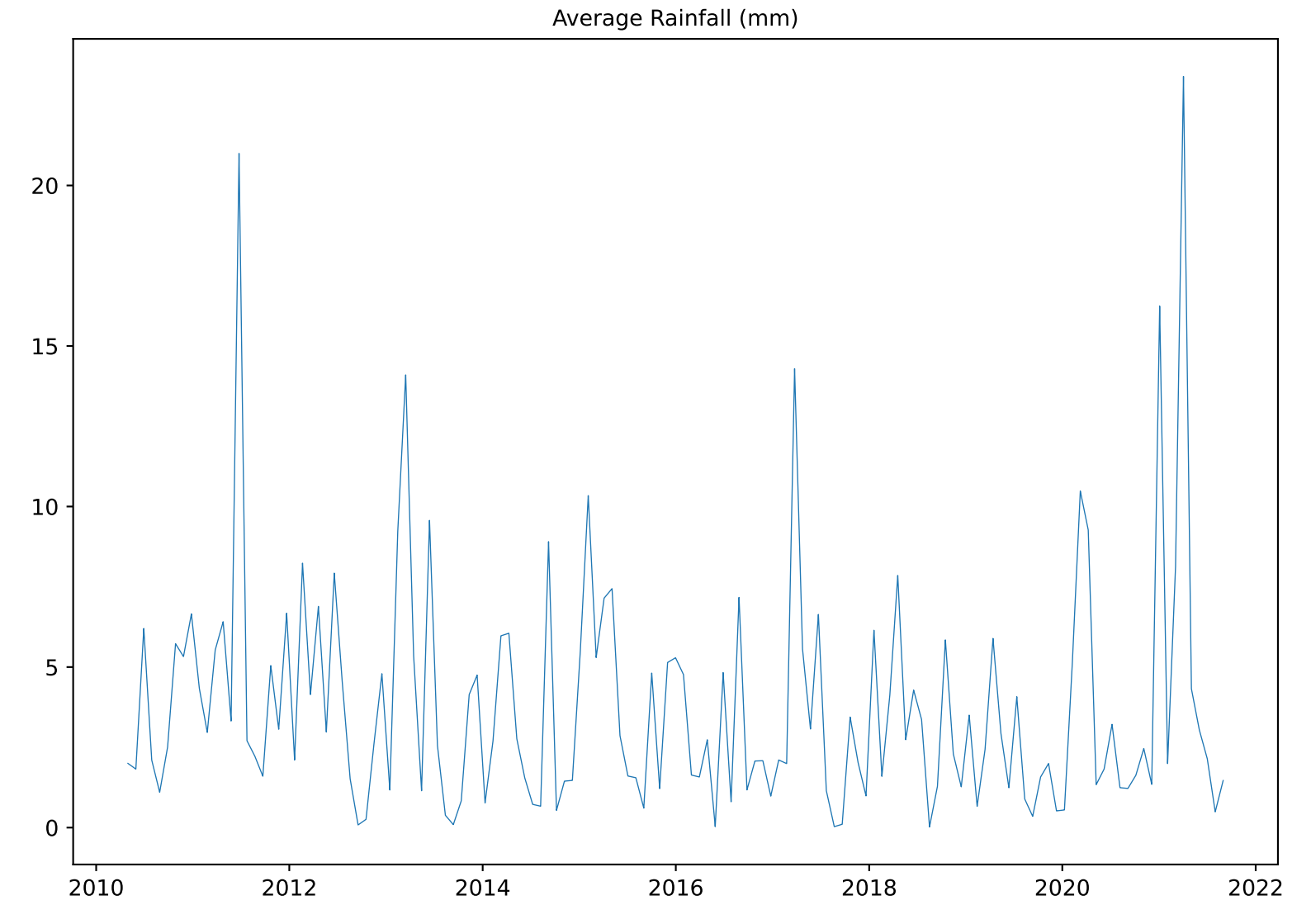
<><> Model Inputs <><>

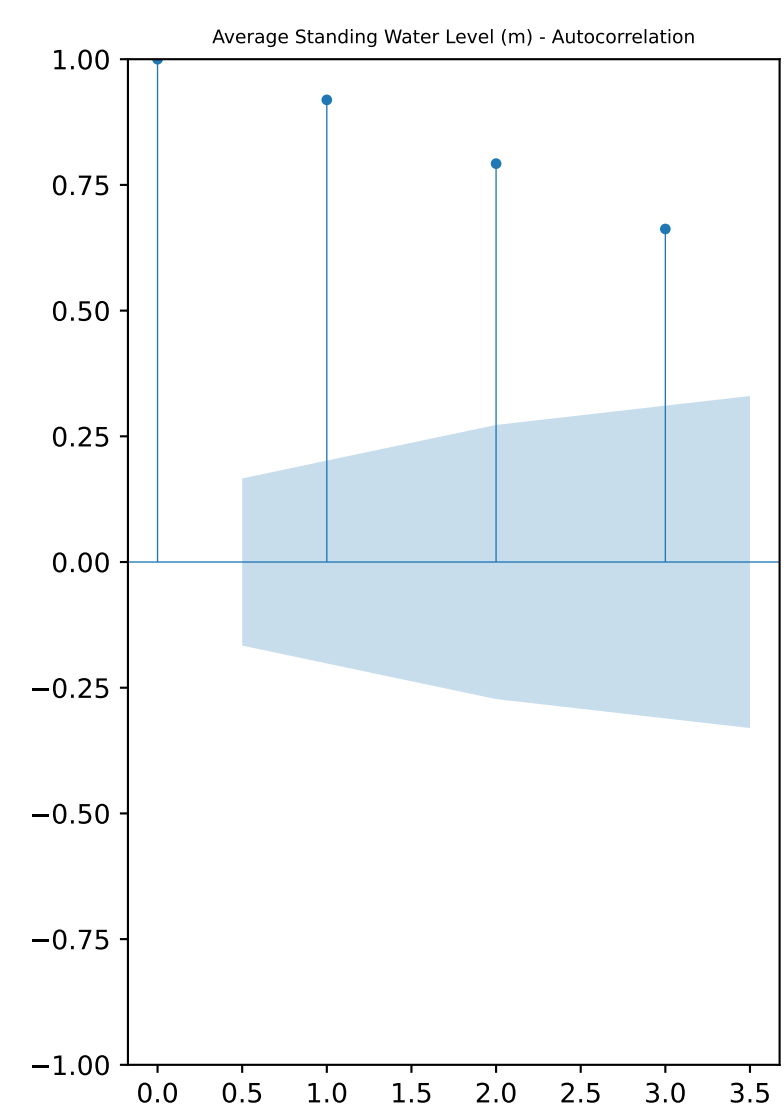
Data Range: 01/05/2010 - 31/08/2021
Train Set Size: 80.0%
Test Set Size: 20.0%
Input Timesteps: Current period + 2 preceeding period(s)
Input Variables:
    Average Standing Water Level (m)
    Average Rainfall (mm)

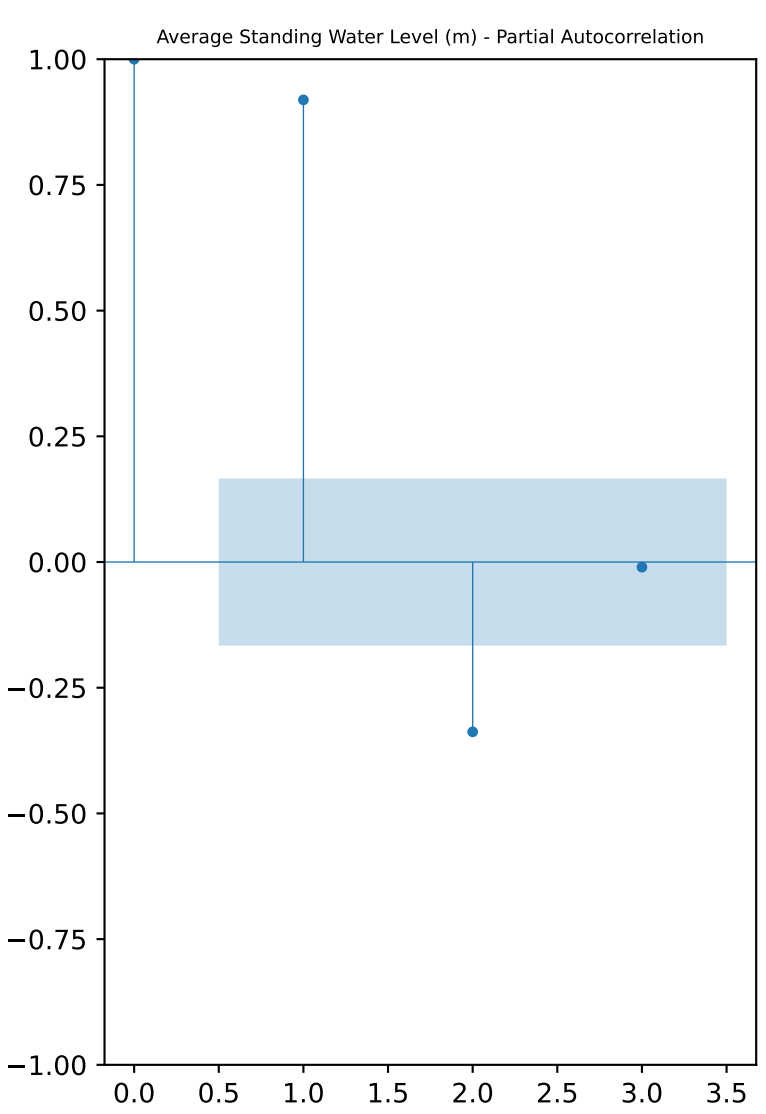
<><> Data Quality <><>

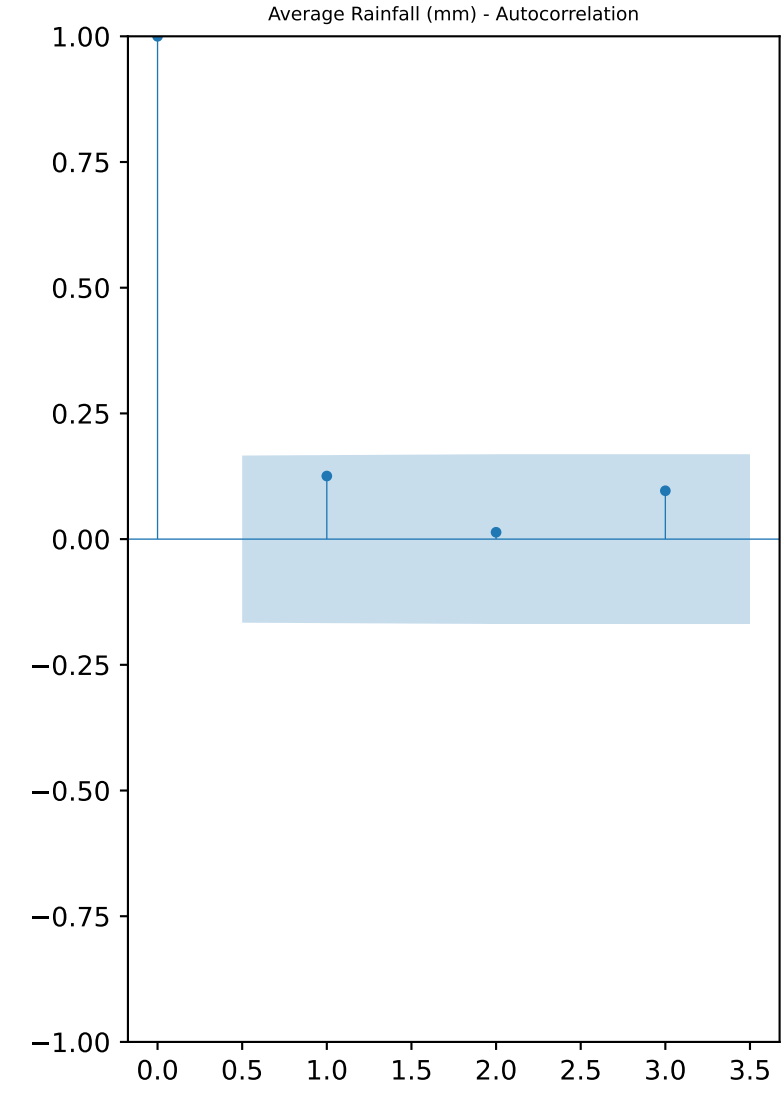
Interpolation Method: Spline
Quality Code: A,   Number: 3434,   Percentage: 82.33%
Quality Code: B,   Number: 645,   Percentage: 15.46%
Quality Code: C,   Number: 92,   Percentage: 2.21%

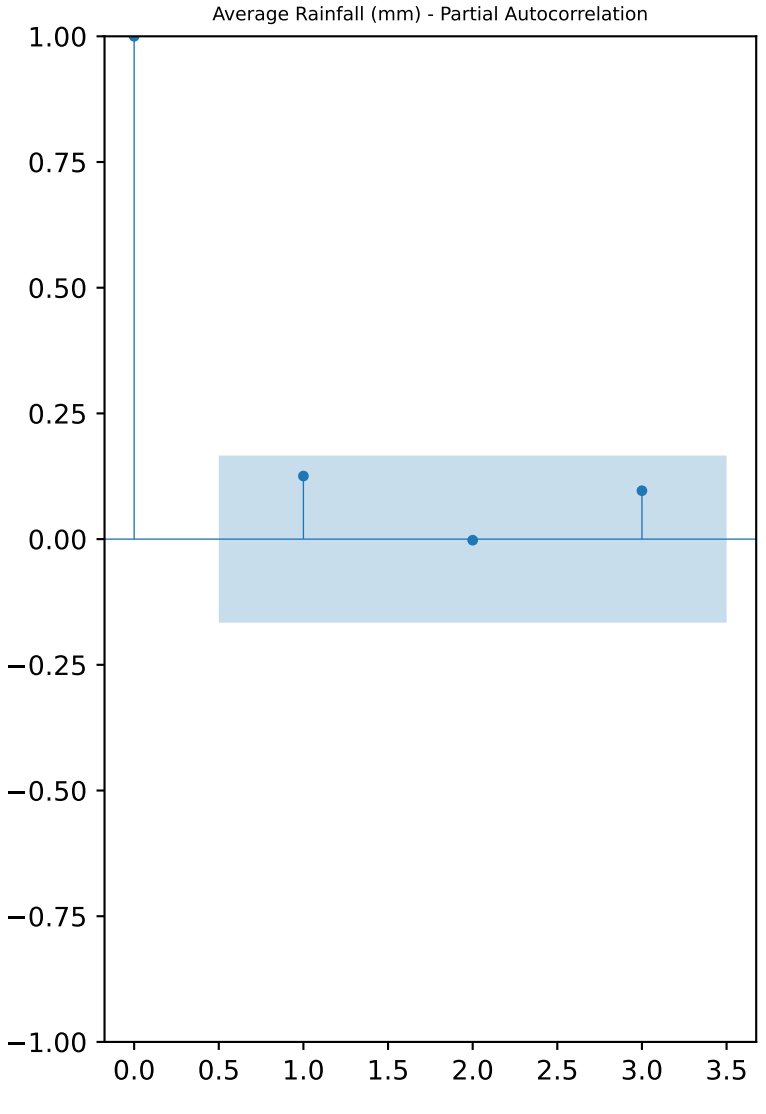

Average Standing Water Level (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2010
2012
2014
2016
2018
2020
2022

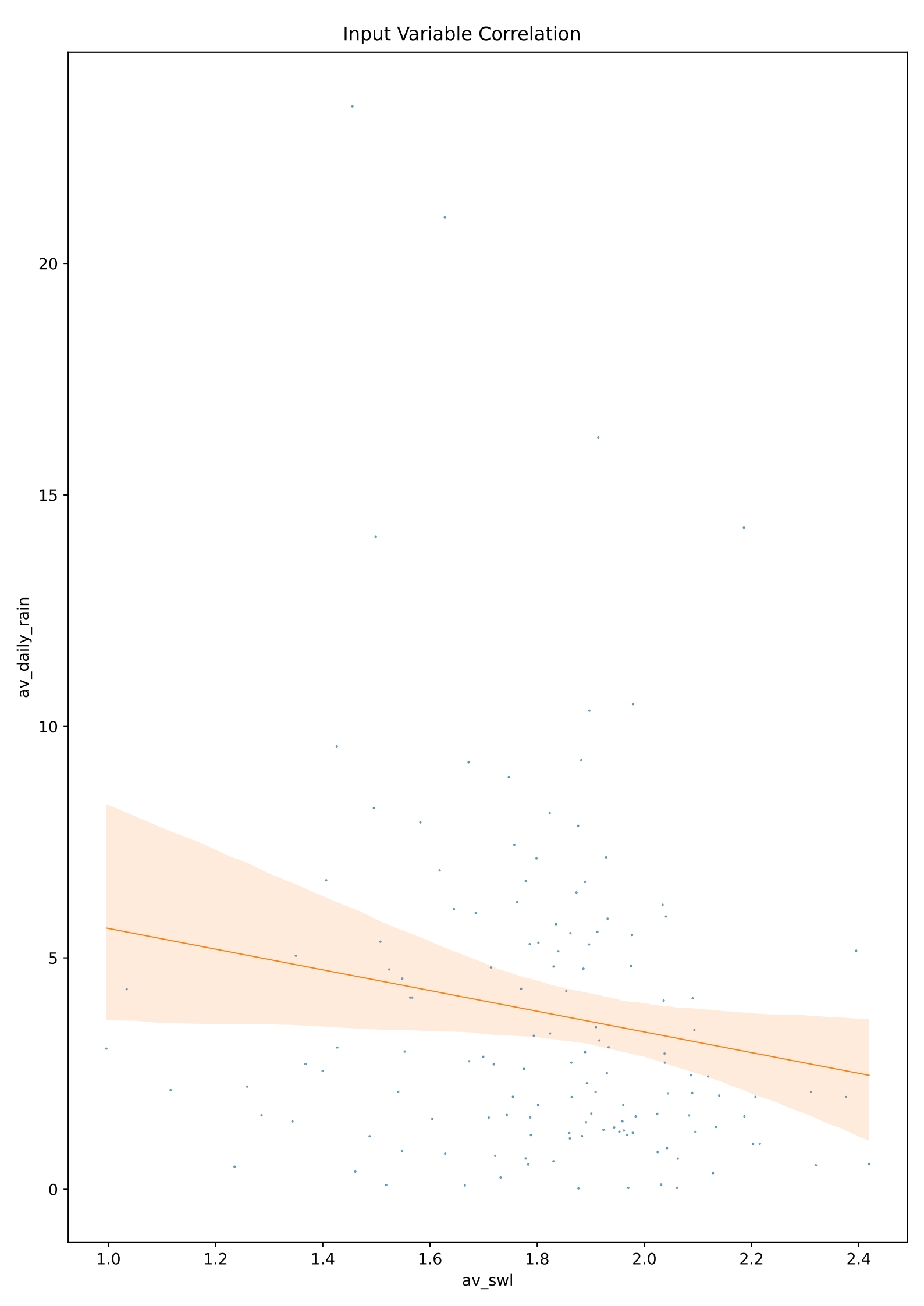

Average Rainfall (mm)
20
15
10
5
0
2010
2012
2014
2016
2018
2020
2022

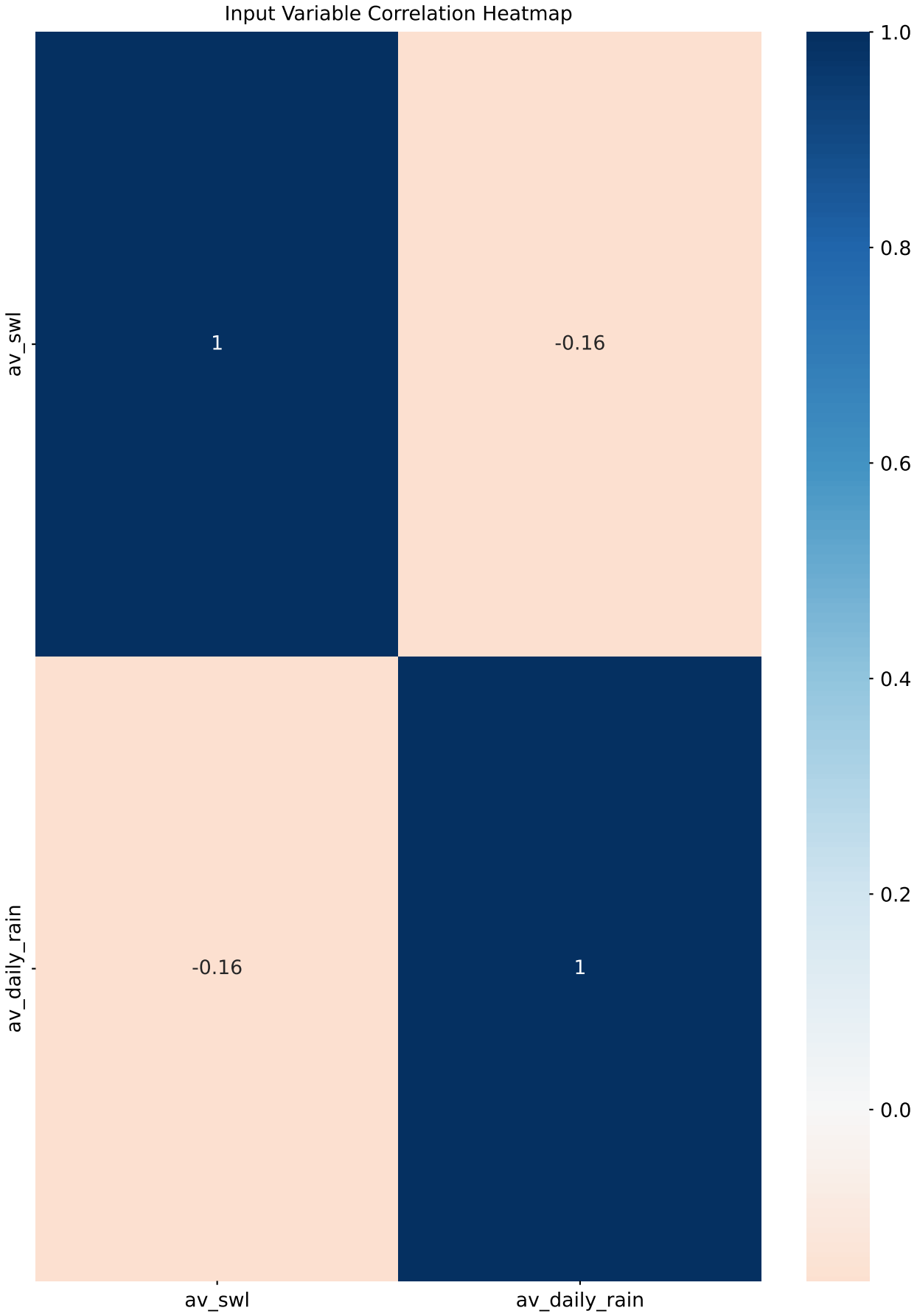

Average Standing Water Level (m) - Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5


Average Standing Water Level (m) - Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5


Average Rainfall (mm) - Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5


Average Rainfall (mm) - Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5


Input Variable Correlation
av_daily_rain
0
5
10
15
20
av_swl
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4


Input Variable Correlation Heatmap
av_swl
av_daily_rain
1
-0.16
-0.16
1
av_swl
av_daily_rain
1.0
0.8
0.6
0.4
0.2
0.0

<><> TensorFlow Keras LSTM Model <><>

Optimiser: adam
Loss: mse
Number of Epochs: 100
Percentage of Training Data for Validation: 20.0%
Time Series Order: Chronological
Verbose: Off

<><> Model Architecture <><>

Input Shape (Samples, Timesteps, Features): (108, 3, 2)
LSTM Layers: 1
LSTM Cells per Layer: 64
Fully Connected Hidden Layers: 2
Fully Connected Hidden Neurons per Layer: 32
Fully Connected Output Neurons: 1
LSTM Dropout Rate: 20.0%
LSTM Recurrent Dropout Rate: 20.0%

Model: "sequential_233"

Layer (type)	Output Shape	Param #
lstm_253 (LSTM)	(None, 64)	17152
dense_534 (Dense)	(None, 32)	2080
dense_535 (Dense)	(None, 32)	1056
dense_536 (Dense)	(None, 1)	33

Total params: 20,321
Trainable params: 20,321
Non-trainable params: 0

<><> Training Loss <><>

Epoch: 10,   Loss: 0.029903355985879898
Epoch: 20,   Loss: 0.01428553368896246
Epoch: 30,   Loss: 0.014278887771070004
Epoch: 40,   Loss: 0.013116947375237942
Epoch: 50,   Loss: 0.01501042302697897
Epoch: 60,   Loss: 0.010084678418934345
Epoch: 70,   Loss: 0.012170456349849701
Epoch: 80,   Loss: 0.01654117926955223
Epoch: 90,   Loss: 0.011433389037847519
Epoch: 100,   Loss: 0.01172314677387476

<><> Validation Loss <><>

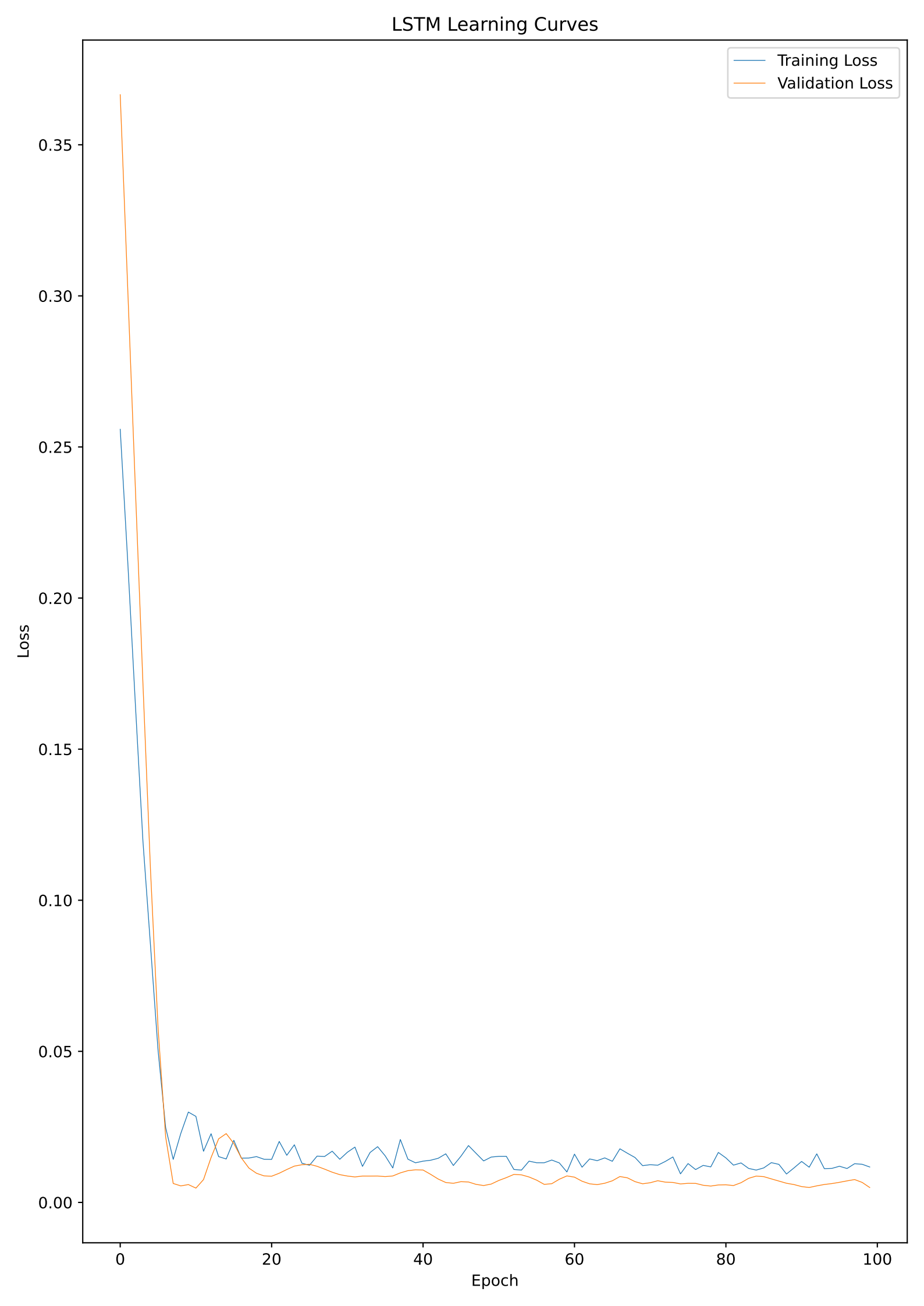
Epoch: 10,   Loss: 0.005911251995712519
Epoch: 20,   Loss: 0.008783102966845036
Epoch: 30,   Loss: 0.00919461902230978
Epoch: 40,   Loss: 0.010794476605951786
Epoch: 50,   Loss: 0.00607529329136014
Epoch: 60,   Loss: 0.008777209557592869
Epoch: 70,   Loss: 0.0061693135648965836
Epoch: 80,   Loss: 0.005783958826214075
Epoch: 90,   Loss: 0.005908884108066559
Epoch: 100,   Loss: 0.004925420042127371

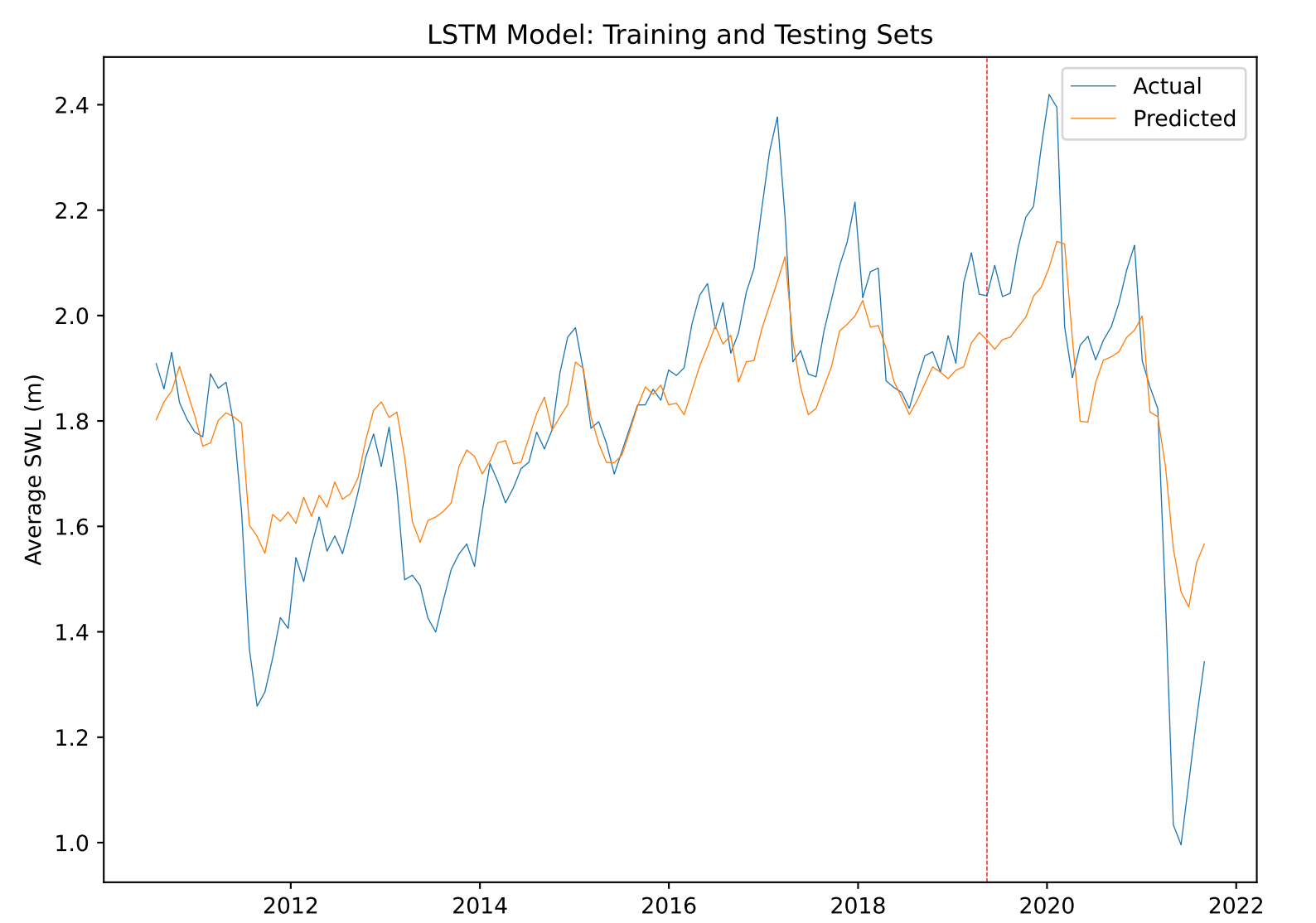
<><> Training Set Scores <><>

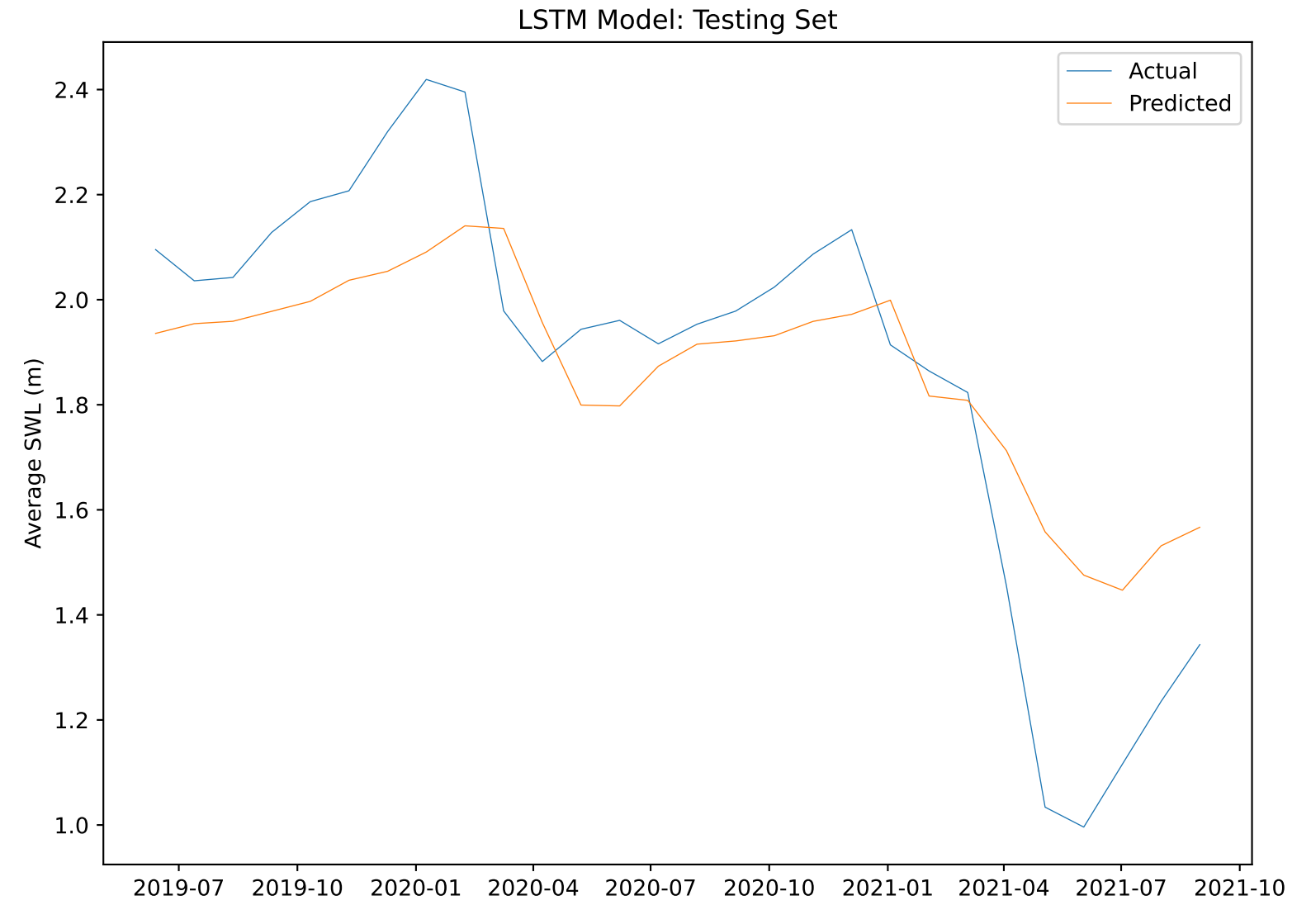
Train Root Mean Squared Error: 0.08407
Train Mean Squared Error: 0.00707
Train Normalised Root Mean Squared Error: 0.1071
Train Coefficient of Determination: 0.71667
Train Normalised Nash Sutcliffe Efficiency: 0.77922
Train Mean Absolute Error: 0.06523
Train Pearson's Correlation Coefficient: 0.93366
Train Index of Agreement: 0.87744
Train Kling-Gupta Efficiency: 0.53591
Train Mean Bias Error: 0.00405
Train Mean Absolute Percentage Error: 0.05398

<><> Test Set Scores <><>

Test Root Mean Squared Error: 0.15329
Test Mean Squared Error: 0.0235
Test Normalised Root Mean Squared Error: 0.15329
Test Coefficient of Determination: 0.68581
Test Normalised Nash Sutcliffe Efficiency: 0.76092
Test Mean Absolute Error: 0.12548
Test Pearson's Correlation Coefficient: 0.94199
Test Index of Agreement: 0.85613
Test Kling-Gupta Efficiency: 0.48991
Test Mean Bias Error: -0.00364
Test Mean Absolute Percentage Error: 0.11513


LSTM Learning Curves
Training Loss
Validation Loss
Loss
Epoch
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
20
40
60
80
100


LSTM Model: Training and Testing Sets
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2012
2014
2016
2018
2020
2022


LSTM Model: Testing Set
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10

LSTM Model: Training and Testing Sets
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2012
2014
2016
2018
2020
2022
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10

<><> Scikit Learn SVR Model <><>

Kernel Function: rbf
Kernel Coefficient: scale
Epsilon: 0.1
Stopping Criterion Tolerance: 1e-05
Regularisation Parameter: 1.0
Shrinking: True
Time Series Order: Chronological
Verbose: Off

<><> Model Architecture <><>

Number of Support Vectors: 15
Input/Support Vector Size: 6

<><> 5-Fold Cross Validation Mean Training Loss <><>

Epoch: 8,   Loss: 0.0019374427545810011
Epoch: 16,   Loss: 0.00567416371292689
Epoch: 24,   Loss: 0.004521279978539594
Epoch: 32,   Loss: 0.003903370531878808
Epoch: 40,   Loss: 0.0036151893188993423
Epoch: 48,   Loss: 0.003431399024793989
Epoch: 56,   Loss: 0.003419250432910341
Epoch: 64,   Loss: 0.003429137211266223
Epoch: 72,   Loss: 0.0033985229589354182
Epoch: 80,   Loss: 0.003339700692594195

<><> 5-Fold Cross Validation Mean Validation Loss <><>

Epoch: 8,   Loss: 0.02183136536234781
Epoch: 16,   Loss: 0.02568272768919654
Epoch: 24,   Loss: 0.027524519166806392
Epoch: 32,   Loss: 0.026476606243362417
Epoch: 40,   Loss: 0.02449853479390369
Epoch: 48,   Loss: 0.024530166551195564
Epoch: 56,   Loss: 0.02066925464506738
Epoch: 64,   Loss: 0.021481066193390567
Epoch: 72,   Loss: 0.010073164262955065
Epoch: 80,   Loss: 0.007383241501958614

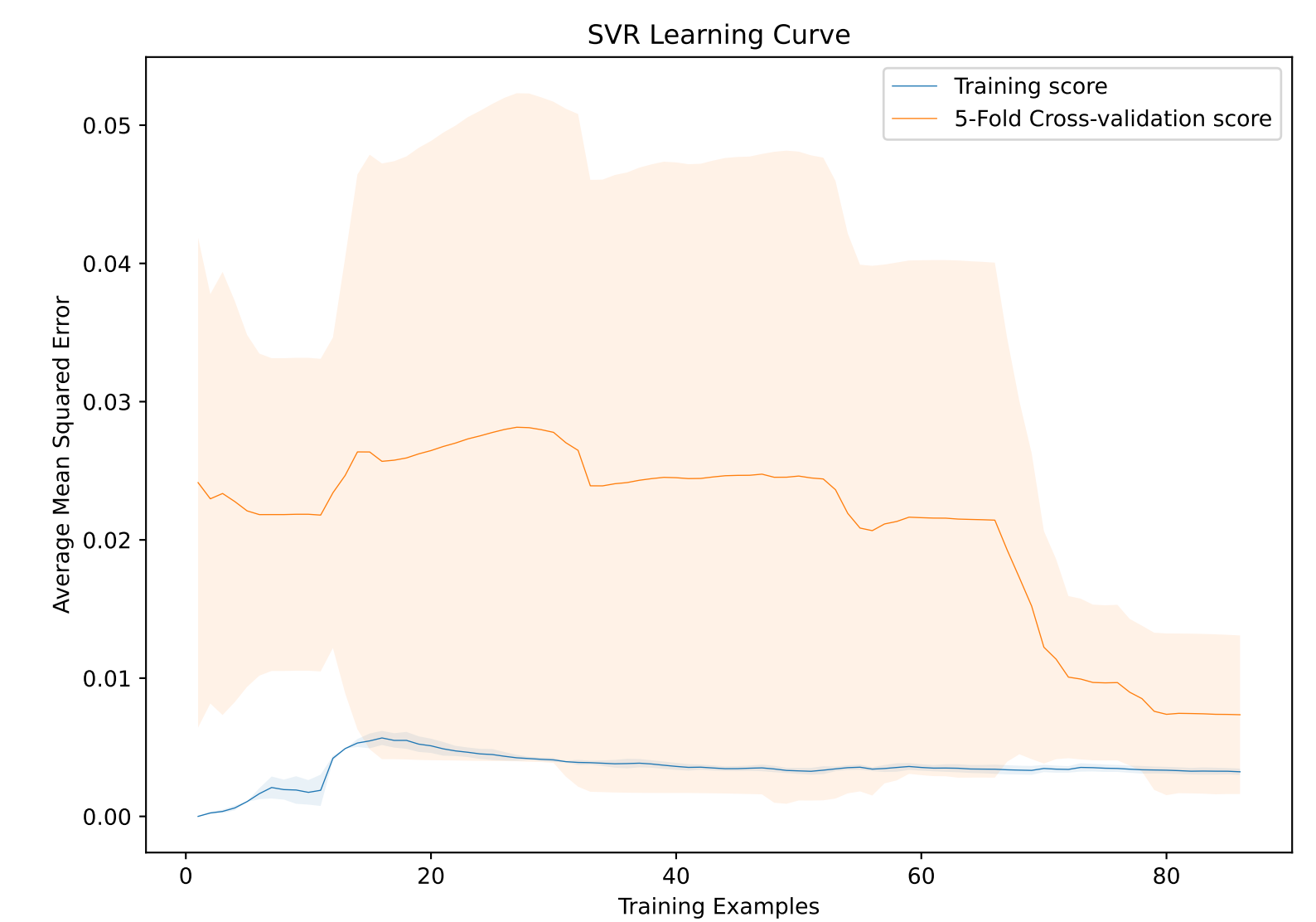
<><> Training Set Scores <><>

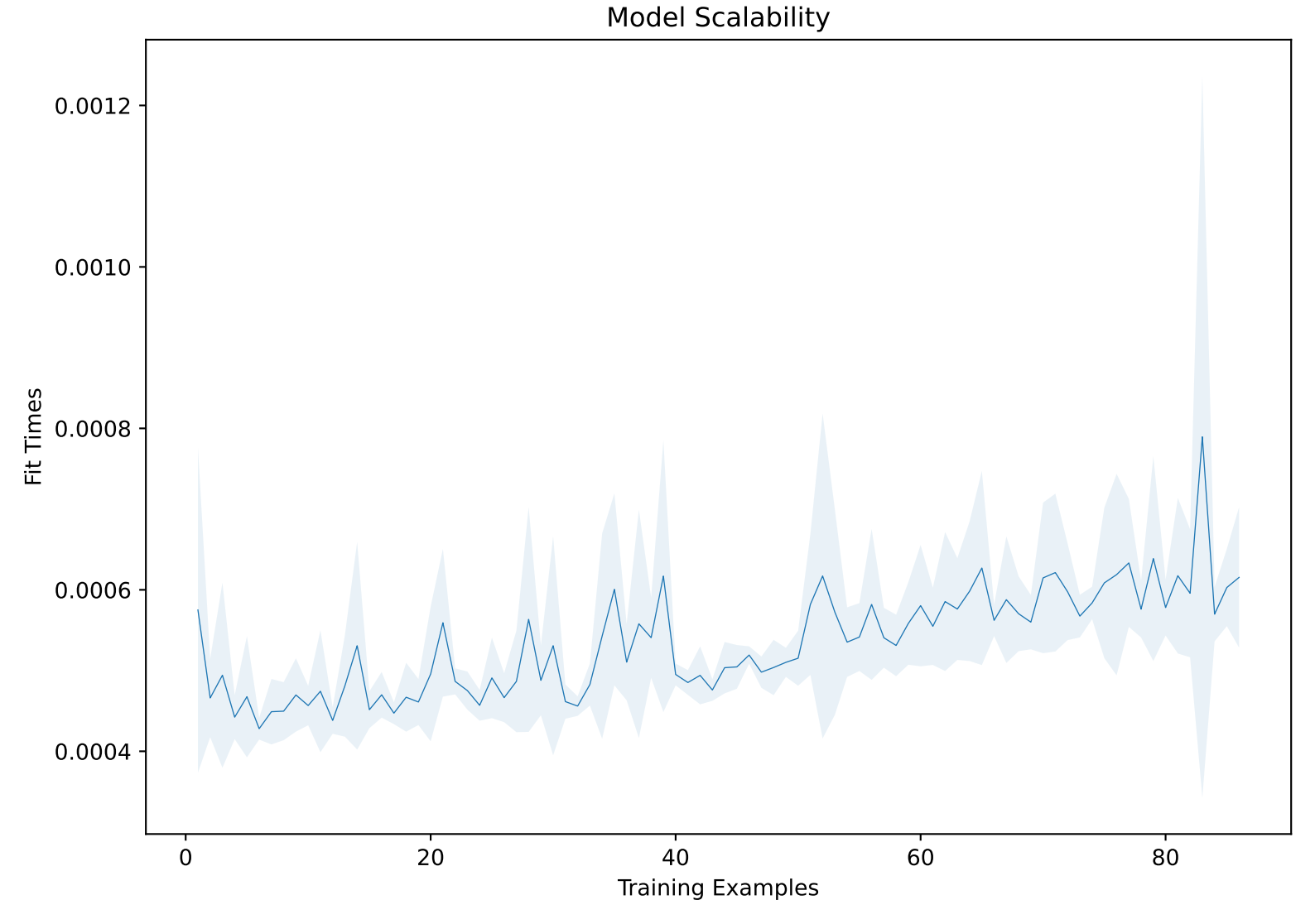
Train Root Mean Squared Error: 0.05559
Train Mean Squared Error: 0.00309
Train Normalised Root Mean Squared Error: 0.07081
Train Coefficient of Determination: 0.87615
Train Normalised Nash Sutcliffe Efficiency: 0.8898

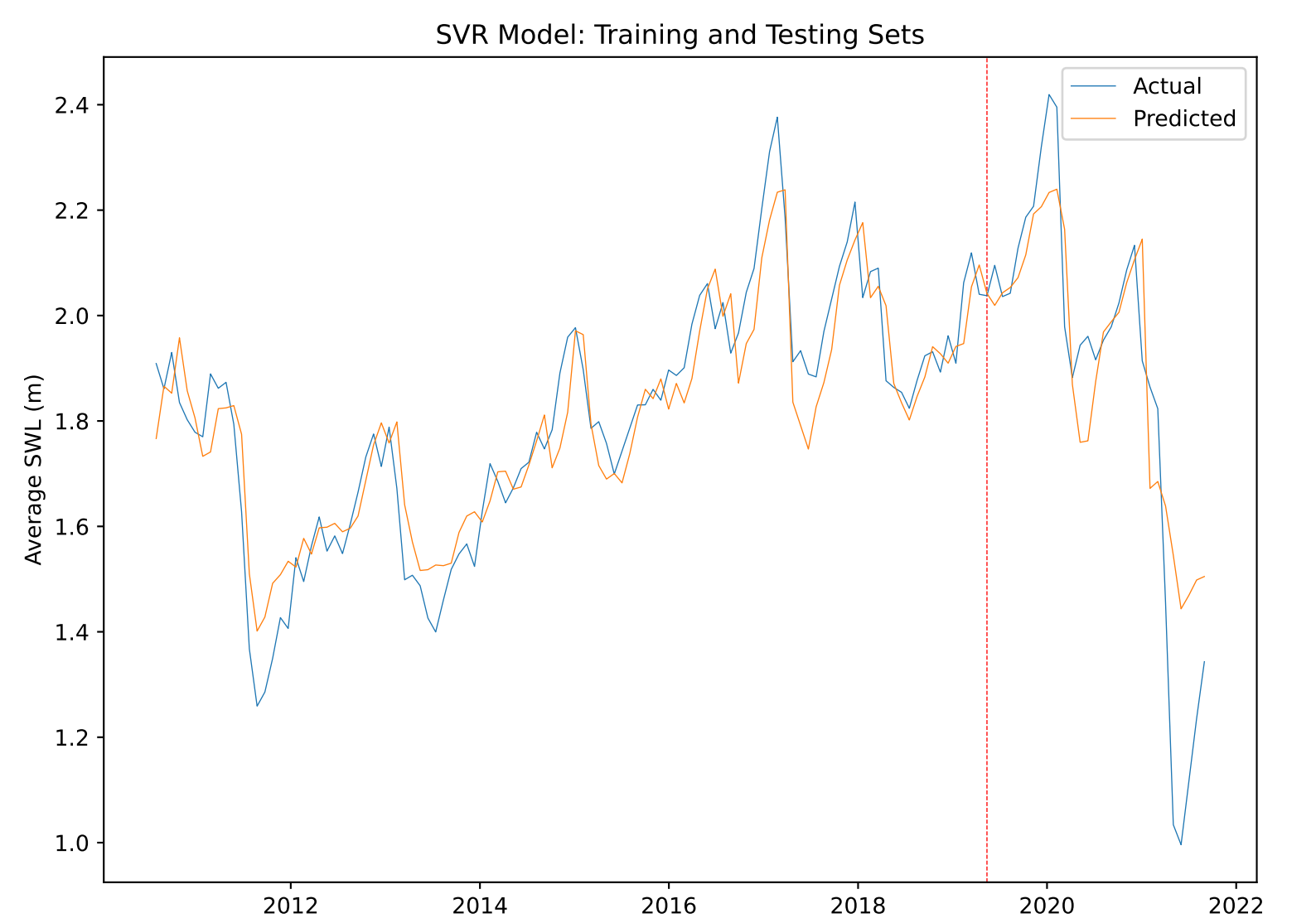
Train Mean Absolute Error: 0.04567
Train Pearson's Correlation Coefficient: 0.94196
Train Index of Agreement: 0.96243
Train Kling-Gupta Efficiency: 0.82777
Train Mean Bias Error: -0.0028
Train Mean Absolute Percentage Error: 0.03693

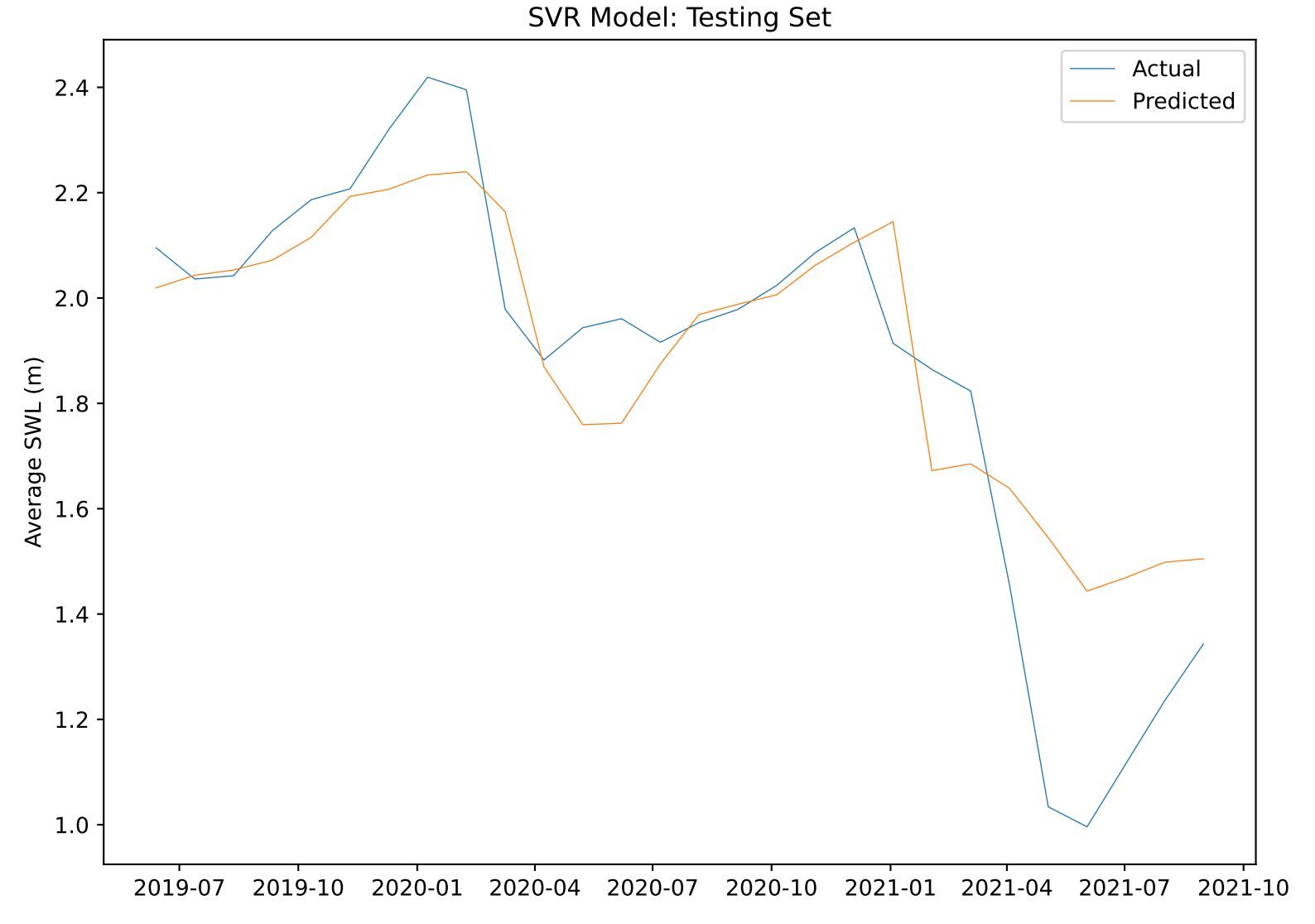
<><> Test Set Scores <><>

Test Root Mean Squared Error: 0.13422
Test Mean Squared Error: 0.01801
Test Normalised Root Mean Squared Error: 0.13422
Test Coefficient of Determination: 0.75913
Test Normalised Nash Sutcliffe Efficiency: 0.80589
Test Mean Absolute Error: 0.09757
Test Pearson's Correlation Coefficient: 0.91287
Test Index of Agreement: 0.90876
Test Kling-Gupta Efficiency: 0.63993
Test Mean Bias Error: 0.02182
Test Mean Absolute Percentage Error: 0.09586


SVR Learning Curve
Training score
5-Fold Cross-validation score
Average Mean Squared Error
0.05
0.04
0.03
0.02
0.01
0.00
0
20
40
60
80
Training Examples


Model Scalability
Fit Times
0.0012
0.0010
0.0008
0.0006
0.0004
0
20
40
60
80
Training Examples


SVR Model: Training and Testing Sets
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2012
2014
2016
2018
2020
2022


SVR Model: Testing Set
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10

SVR Model: Training and Testing Sets
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2012
2014
2016
2018
2020
2022
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10