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"Where will our knowledge take you?"

Wollongong Coastal Zone Management Plan: Management Study Appendices

Final Report September 2017

wollongong
city of innovation

Wollongong Coastal Zone Management Plan: Management Study Appendices

Prepared For:	Wollongong City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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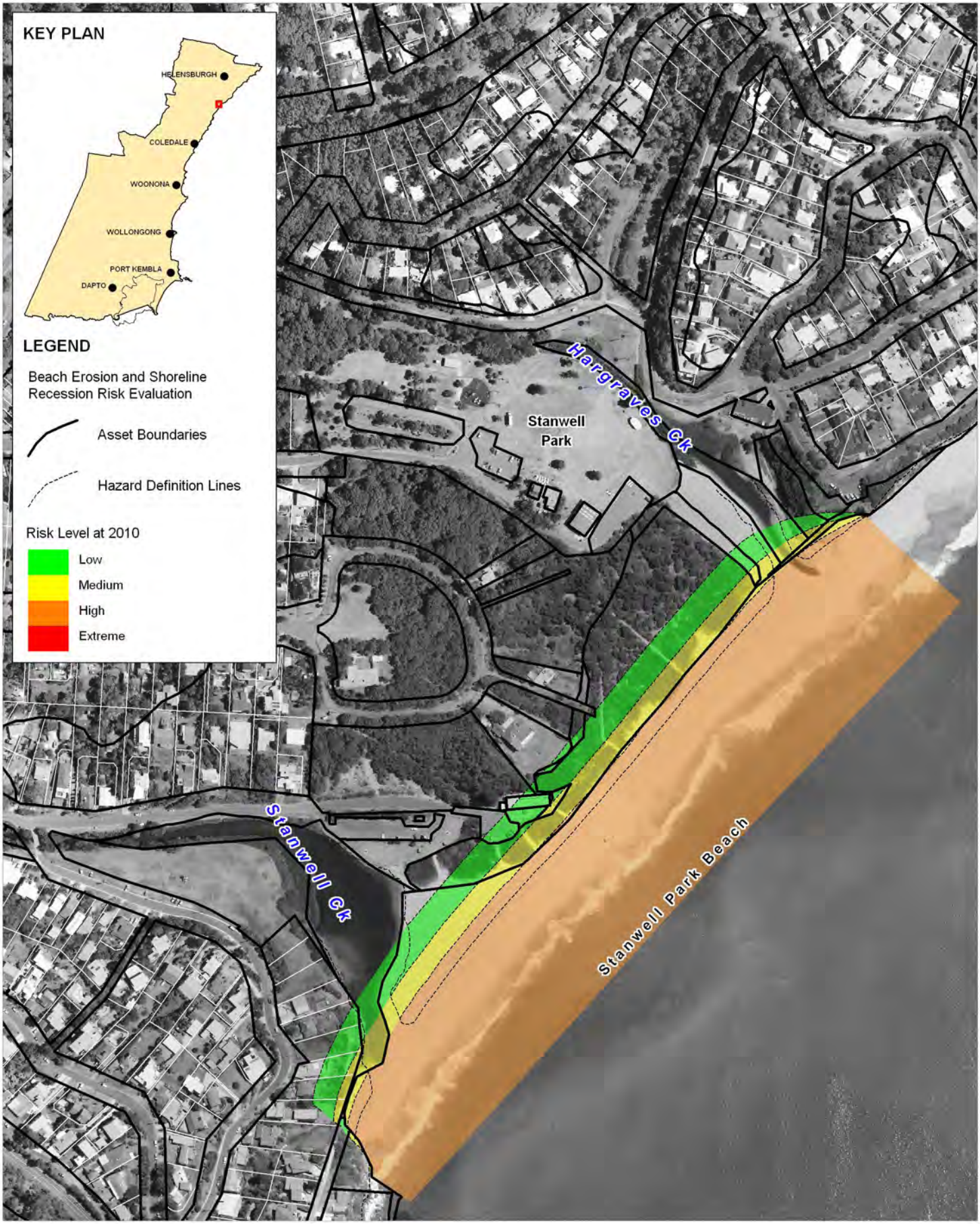
APPENDIX A: RISK LEVELS MAPS FOR THE IMMEDIATE, 2050 AND 2100 TIMEFRAMES



Title:

Erosion and Recession Risk Evaluation
Immediate Horizon Risk - Stanwell Park

Drawing: A-1

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
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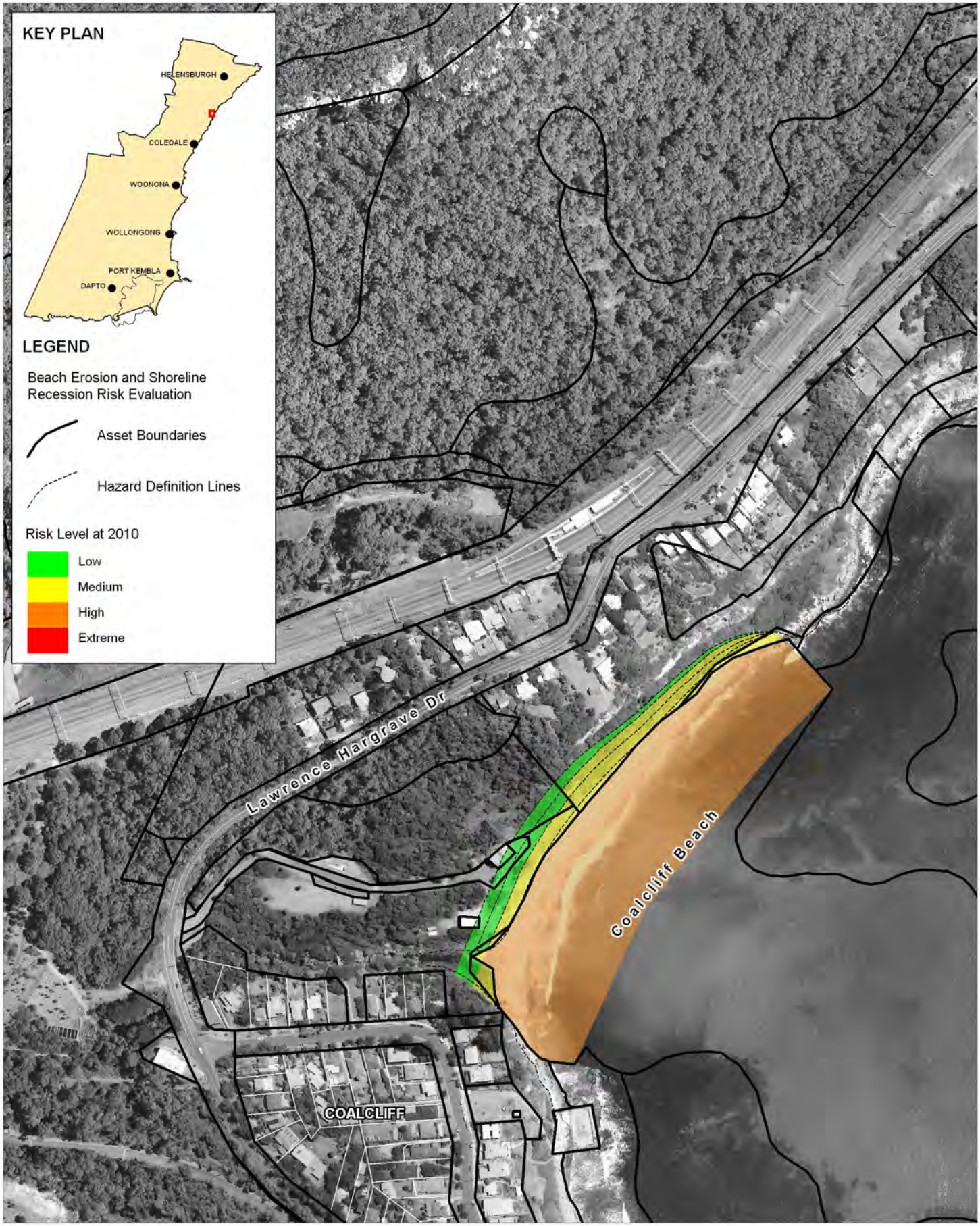
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_101_110317 Drawing A-1.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Coalcliff

Drawing: A-2

Rev: A

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N

0 75 150m

Approx. Scale

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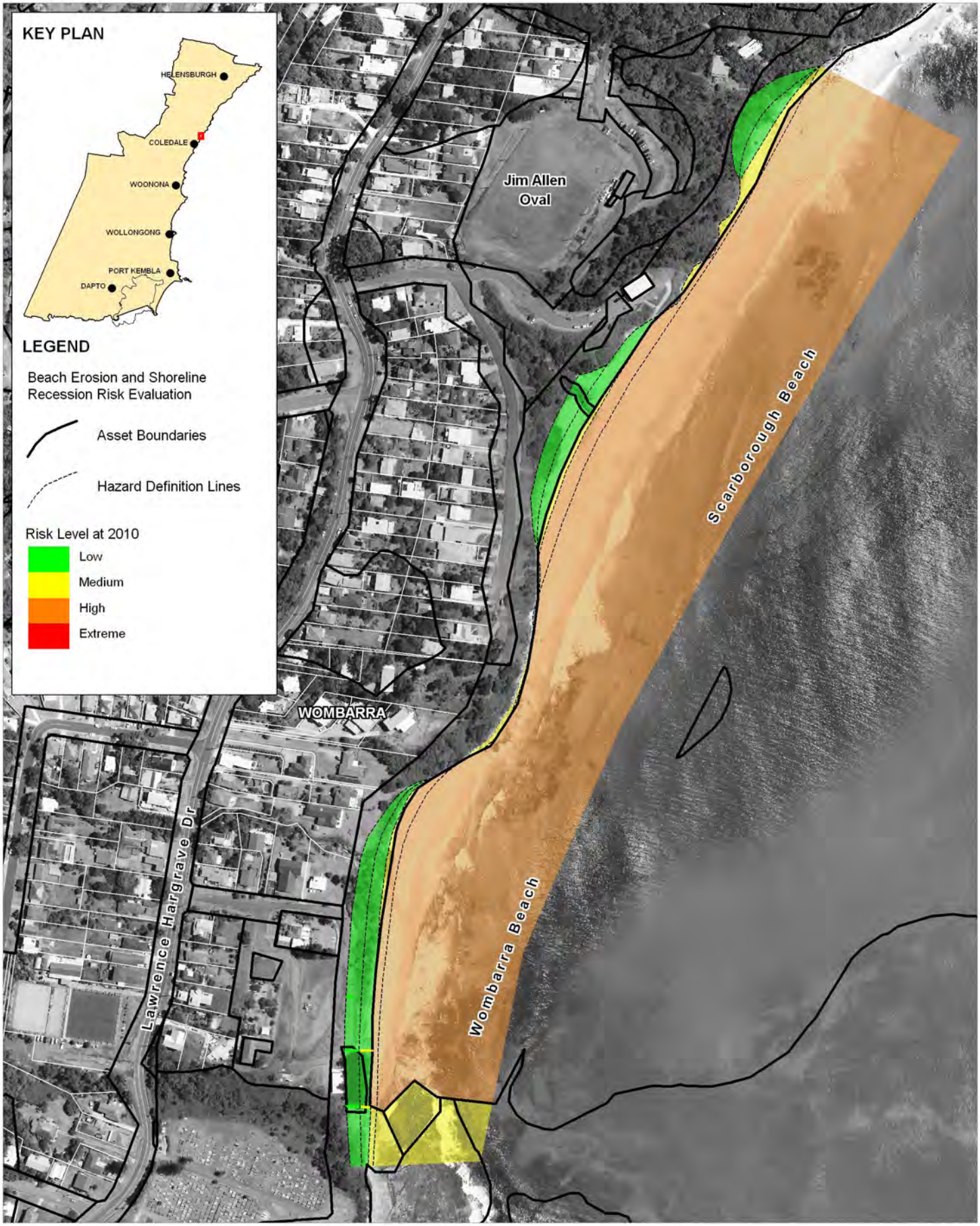

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Scarborough/Wombarra

Drawing: A-3

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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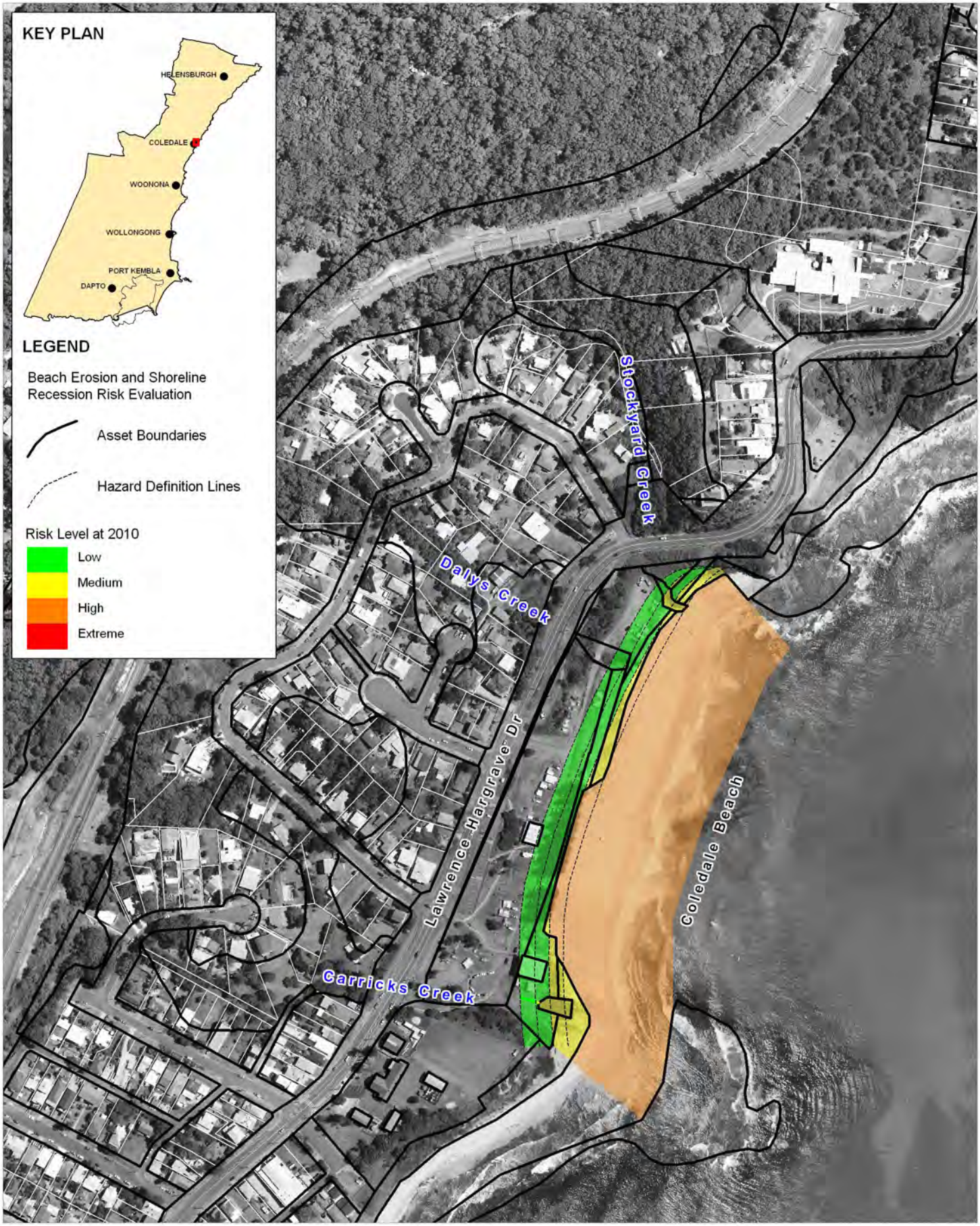

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Coledale

Drawing: A-4

Rev: A

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N

0 75 150m

Approx. Scale

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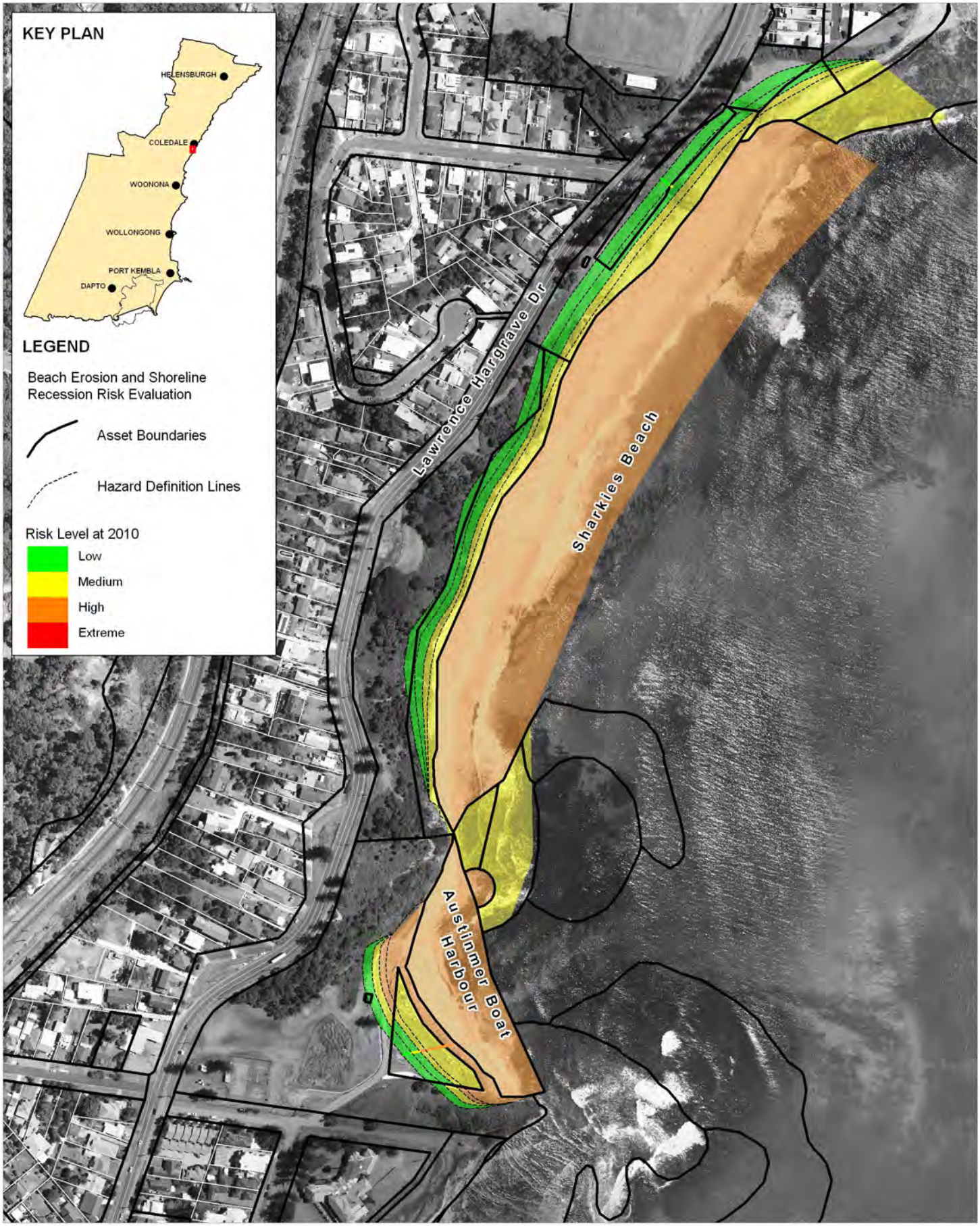

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Sharkies Beach

Drawing: **A-5**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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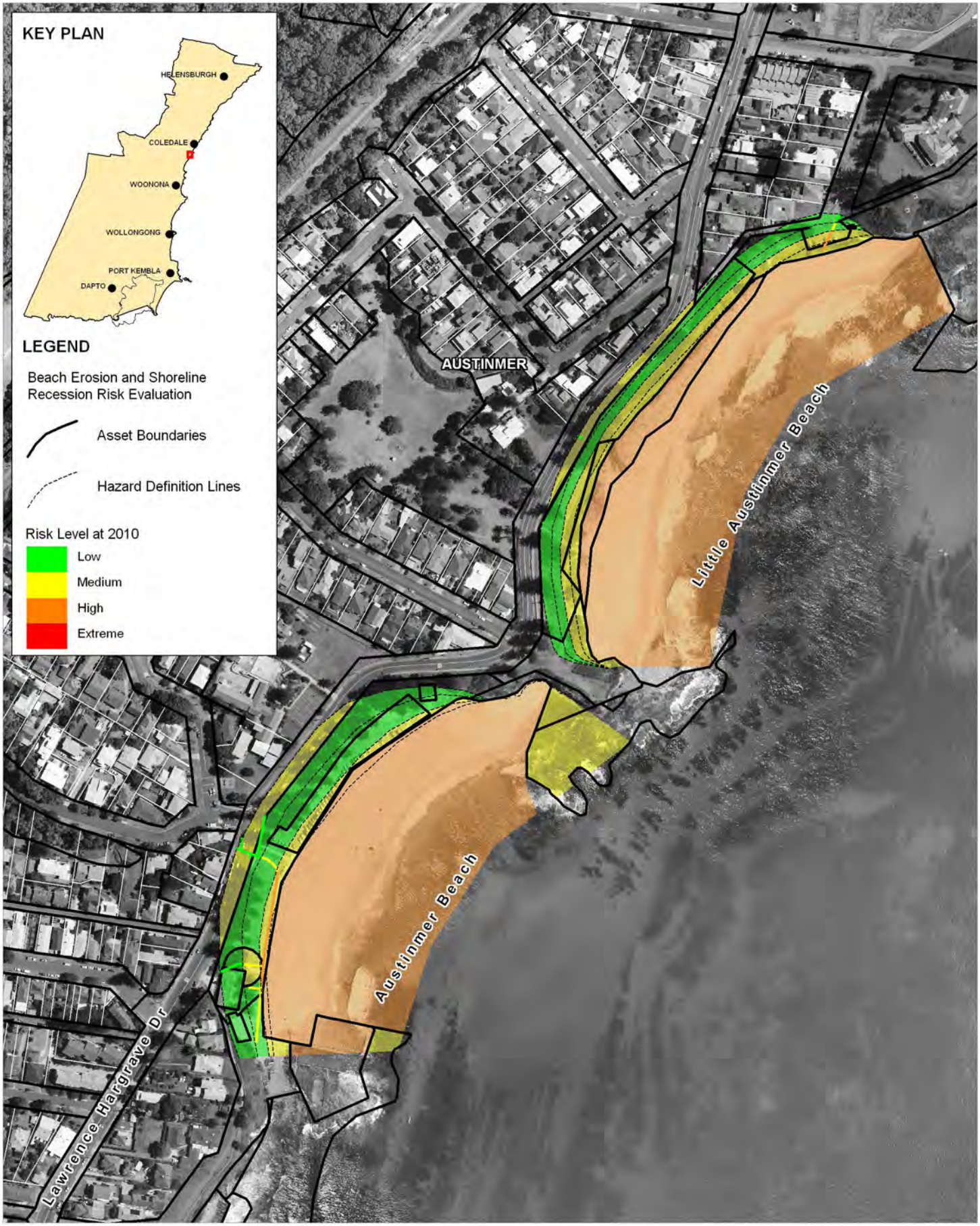
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_105_110414 Drawing A-5.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Austinmer

Drawing: A-6

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
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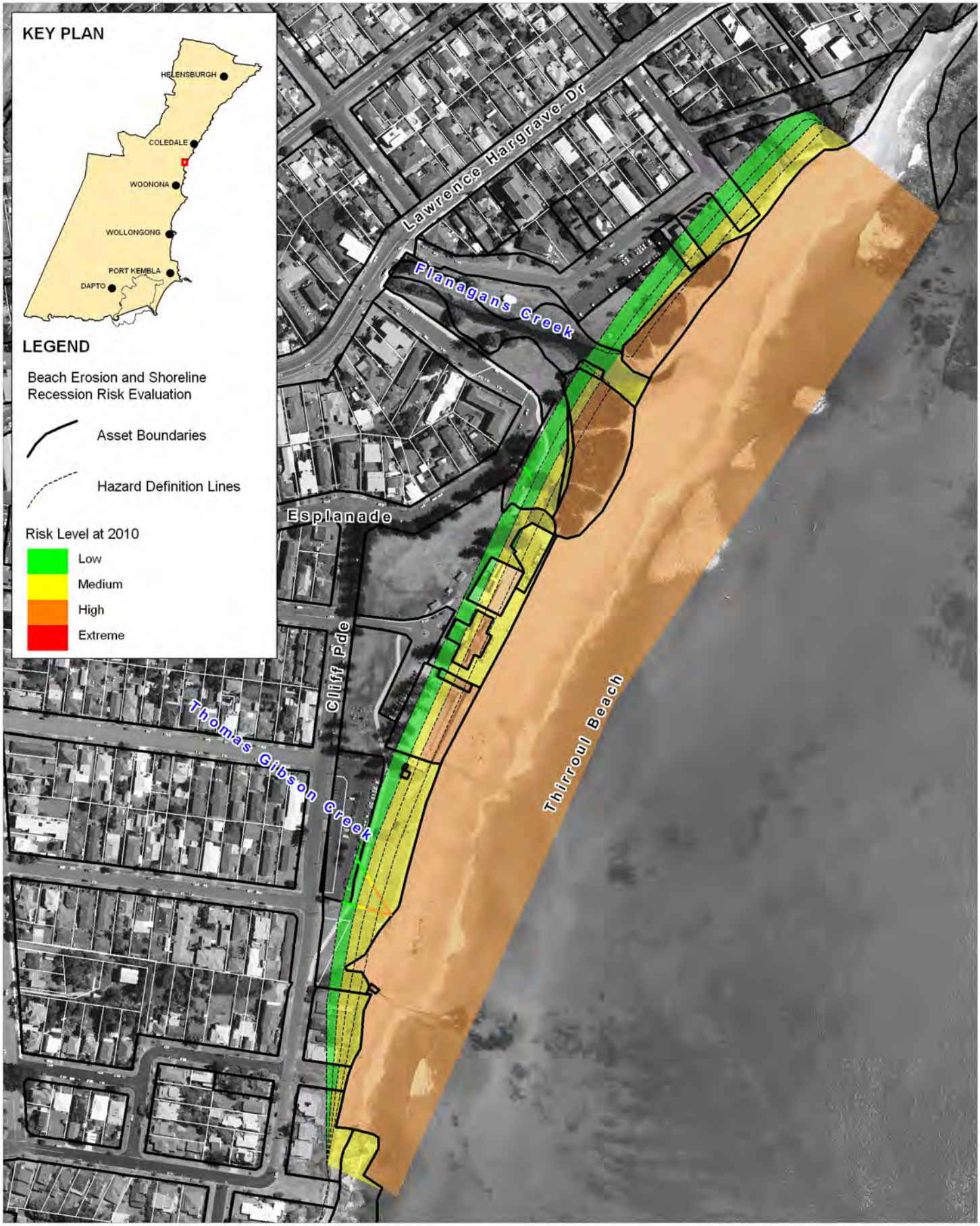
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_106_110414 Drawing A-6.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Thirroul

Drawing: A-7

Rev: A

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N

0 75 150m

Approx. Scale

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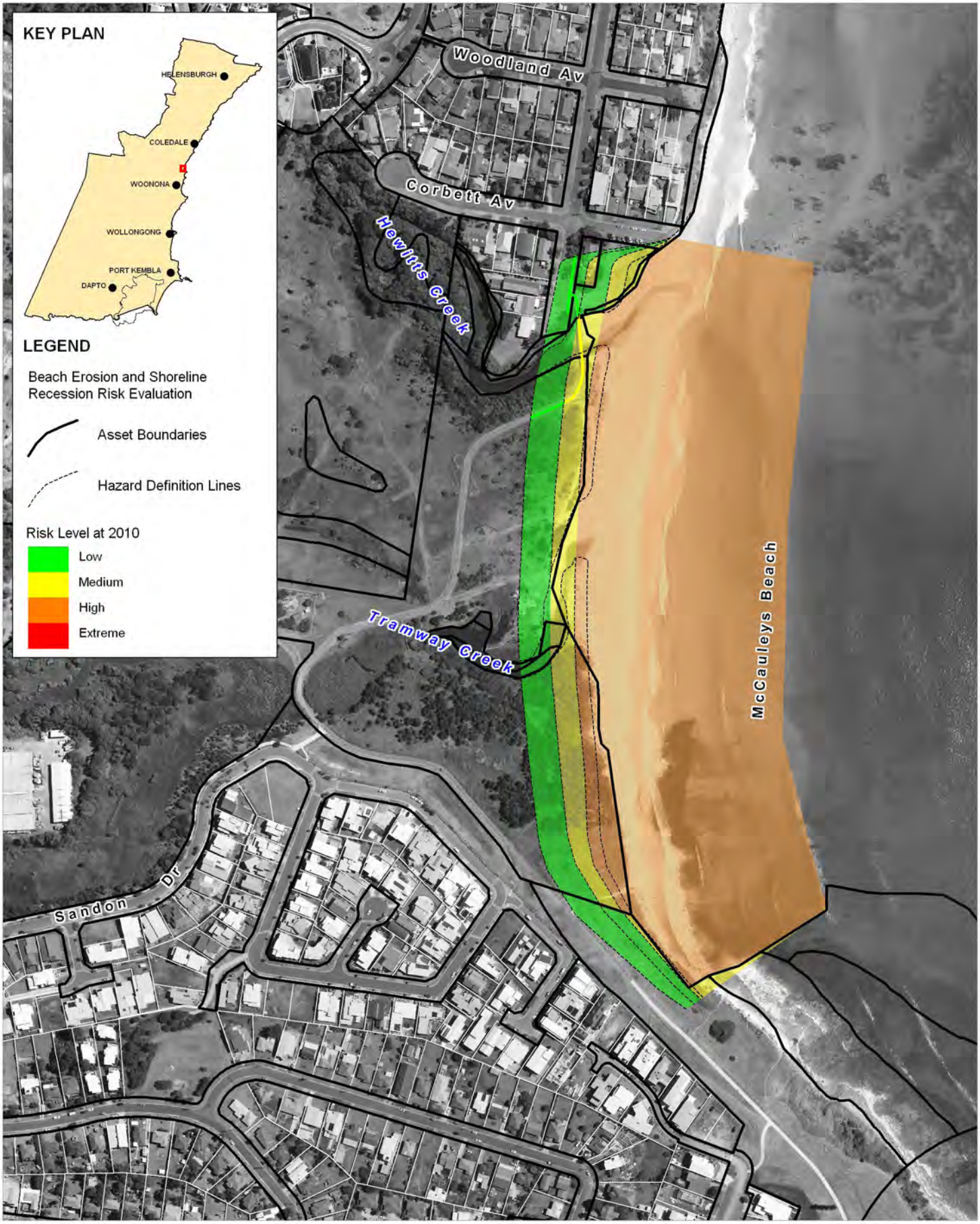

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - McCauleys Beach

Drawing: A-8

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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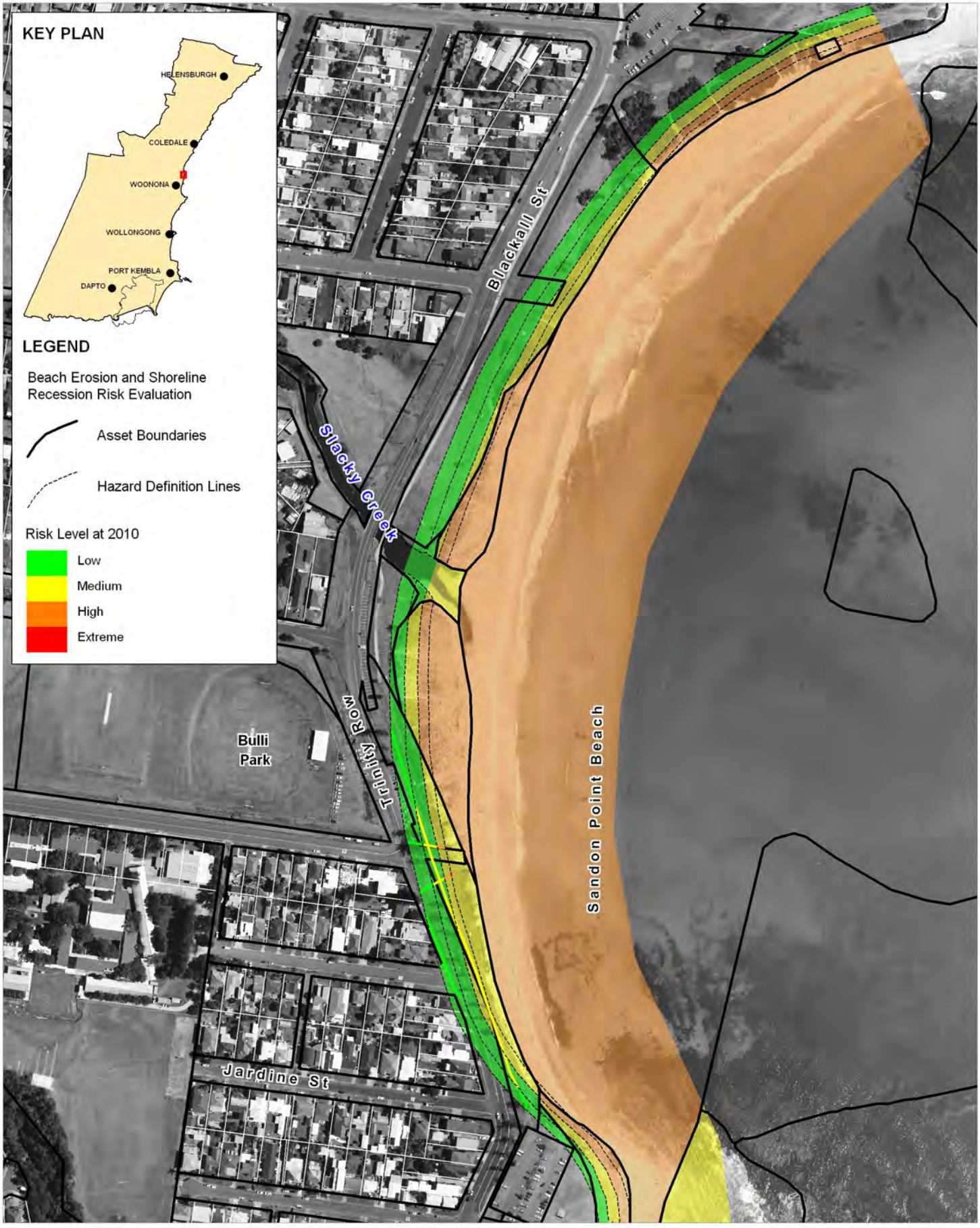
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_108_110414 Drawing A-8.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Sandon Point Beach

Drawing: A-9

Rev: A

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N

0 75 150m

Approx. Scale

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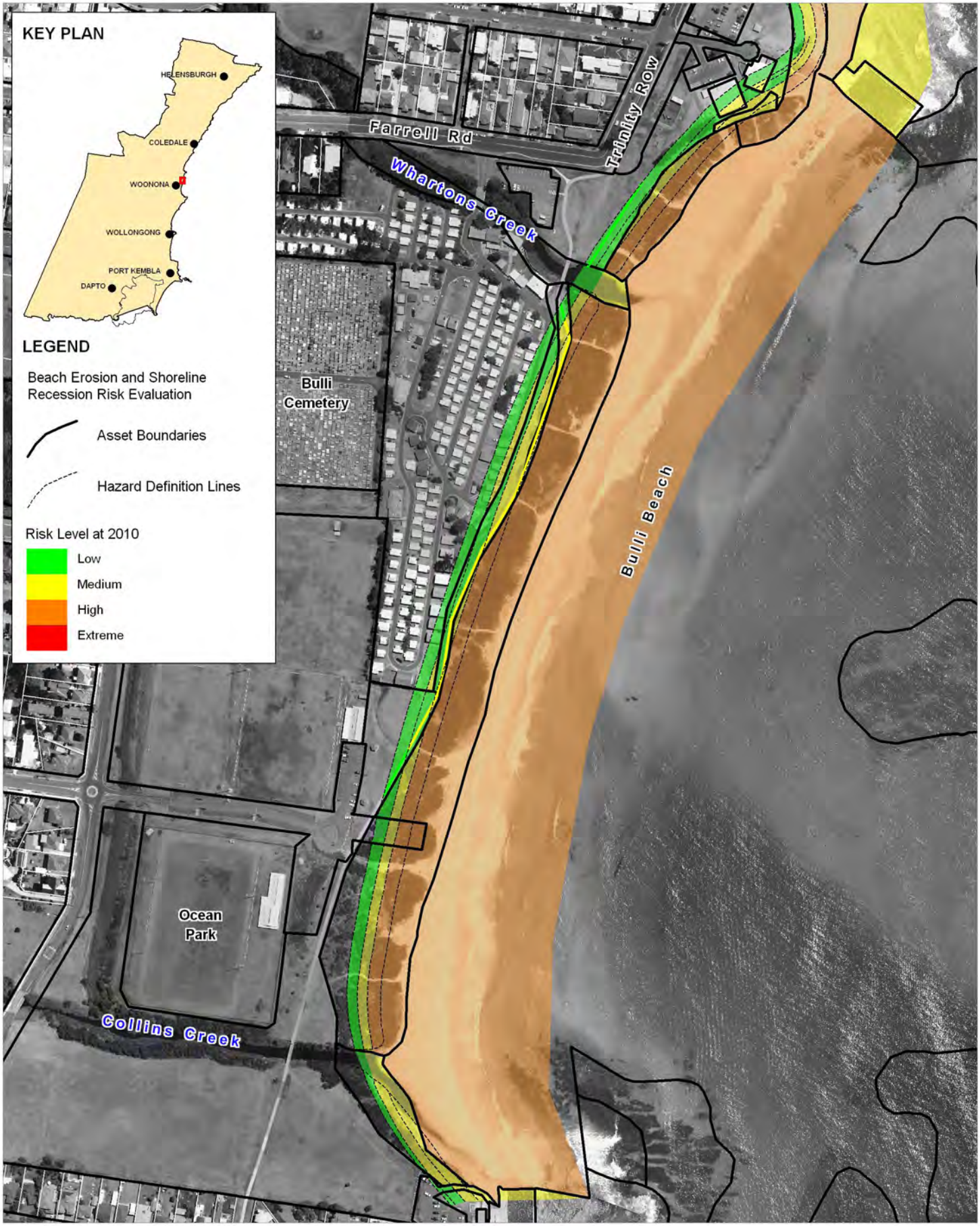
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_109_110414 Drawing A-9.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Bulli Beach

Drawing: A-10

Rev: A

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N

0 75 150m

Approx. Scale

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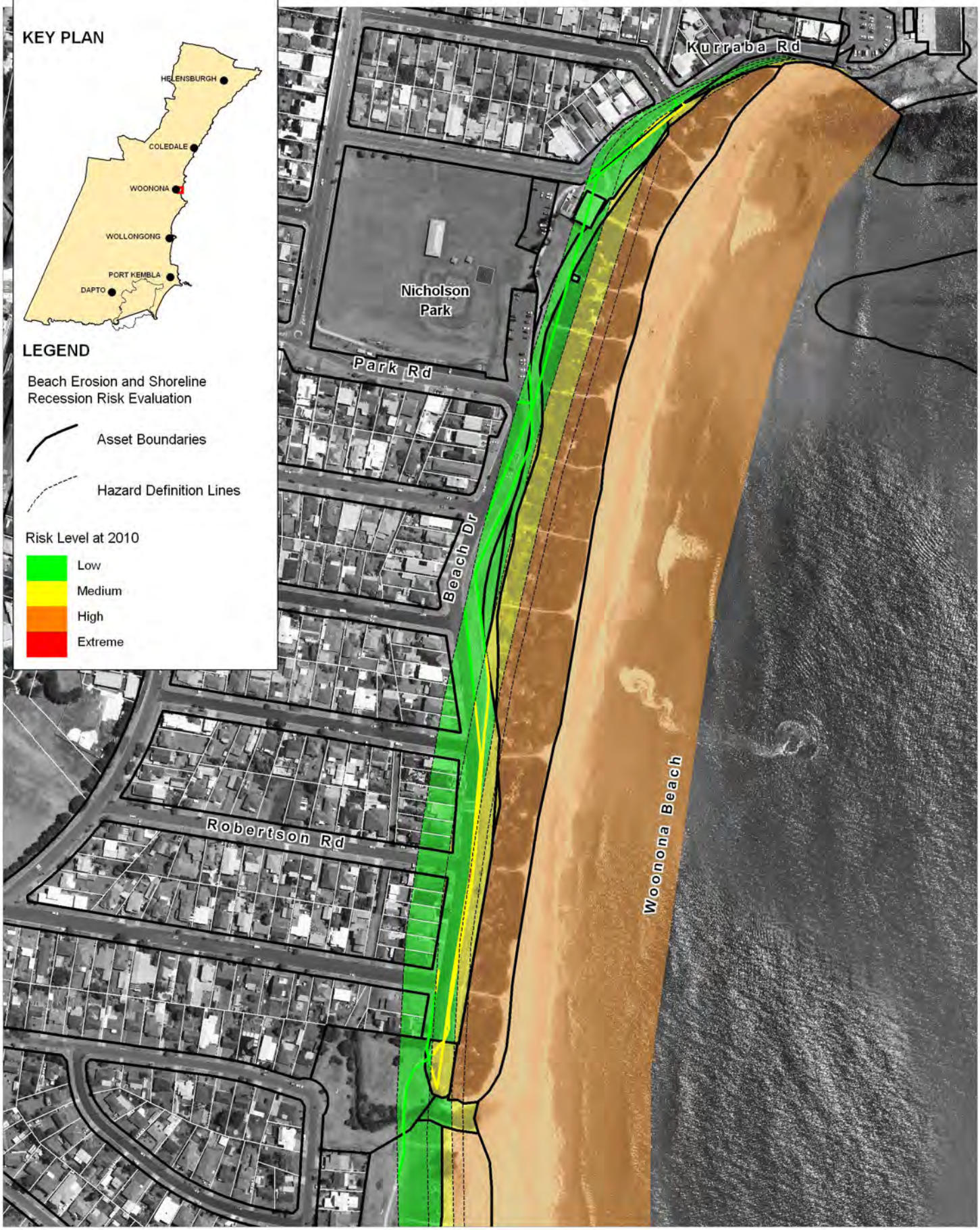
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_110_110414 Drawing A-10.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Woonona Beach

Drawing: A-11

Rev: A

N

0 75 150m

Approx. Scale

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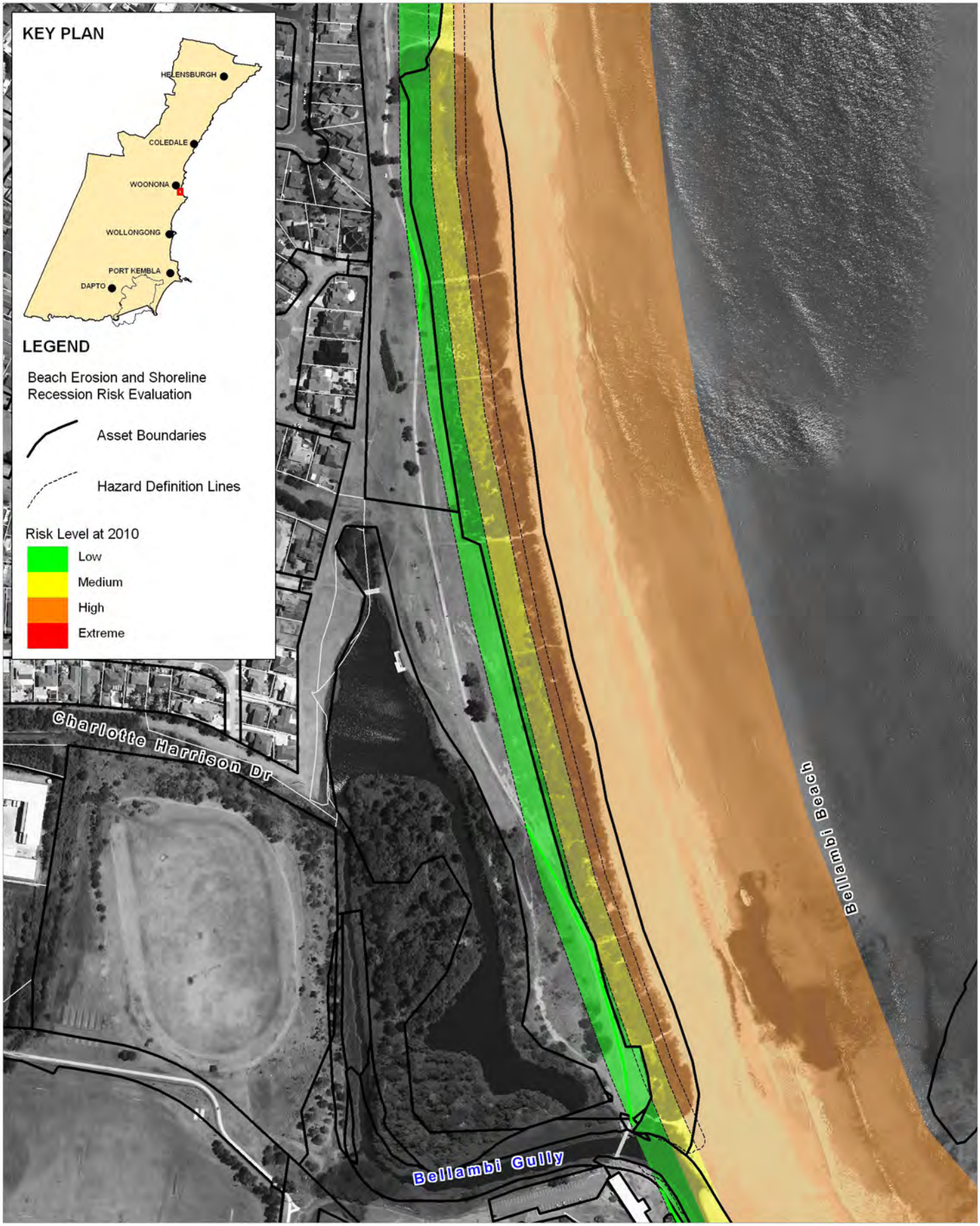
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_111_110414 Drawing A-11.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Bellambi Beach

Drawing: A-12

Rev: A

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N

0 75 150m

Approx. Scale

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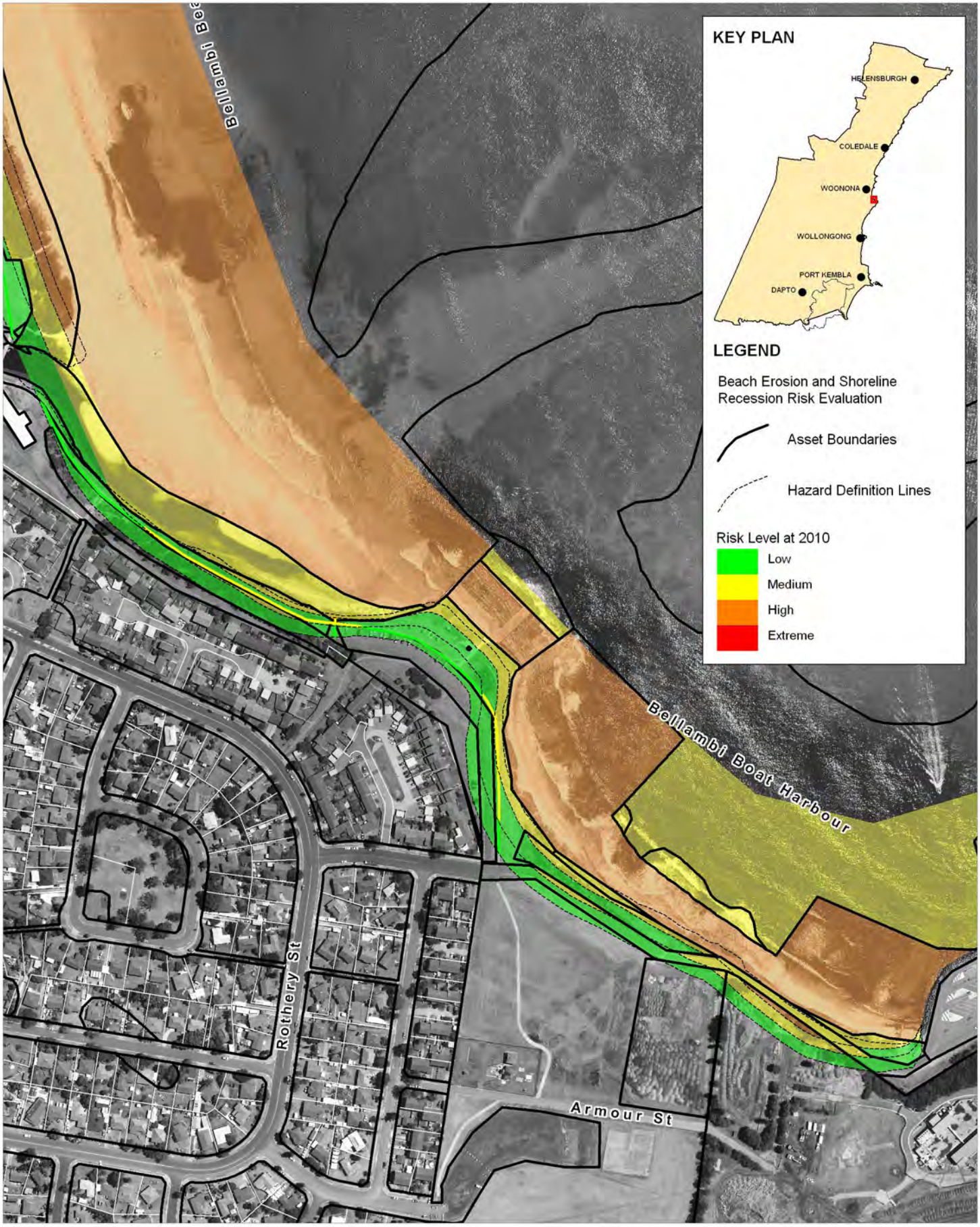
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_112_110414 Drawing A-12.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Bellambi Boat Harbour

Drawing: **A-13**

Rev: **A**

N

0 75 150m

Approx. Scale

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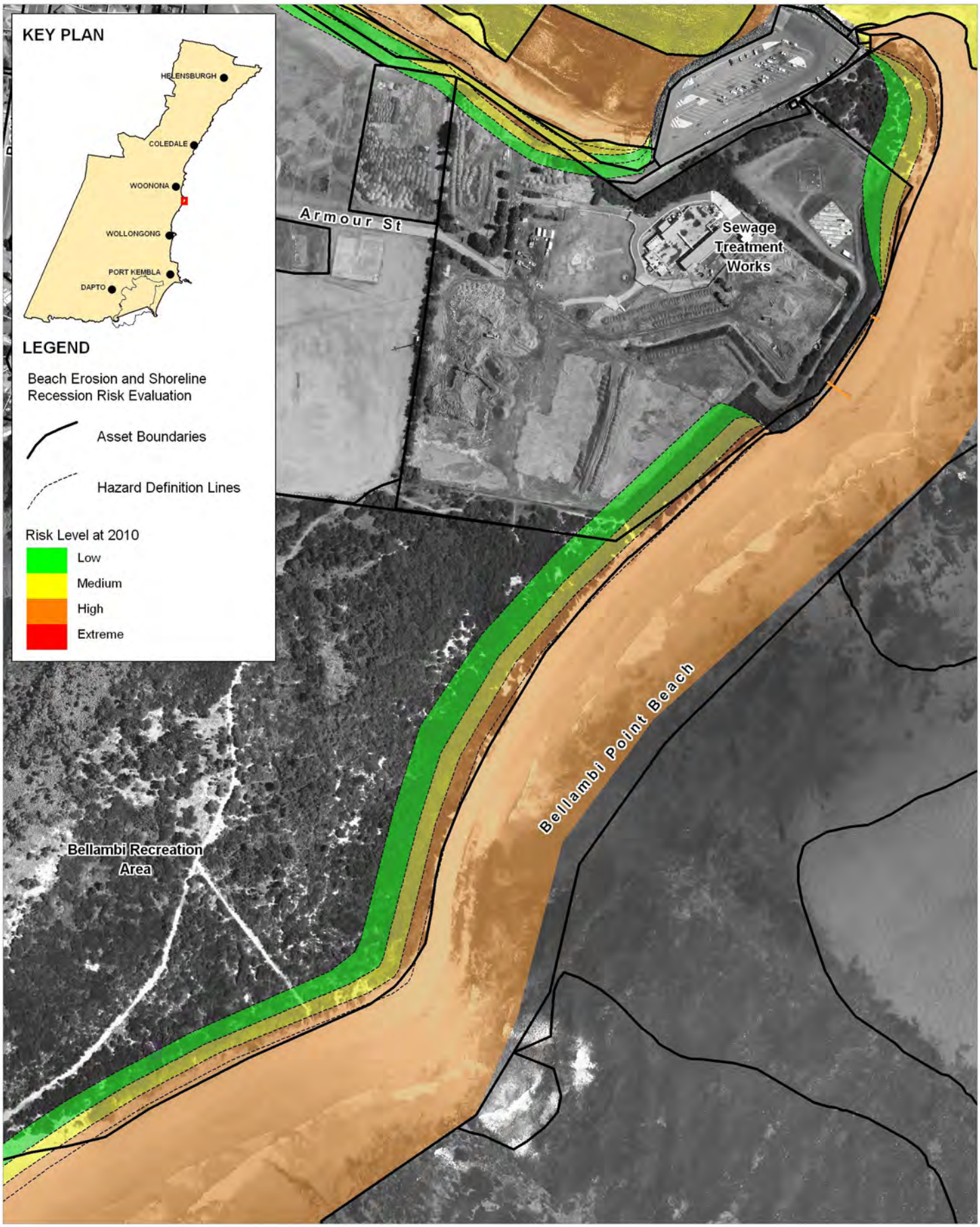
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_113_110414 Drawing A-13.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Bellambi Point Beach

Drawing: A-14

Rev: A

N

0 75 150m

Approx. Scale

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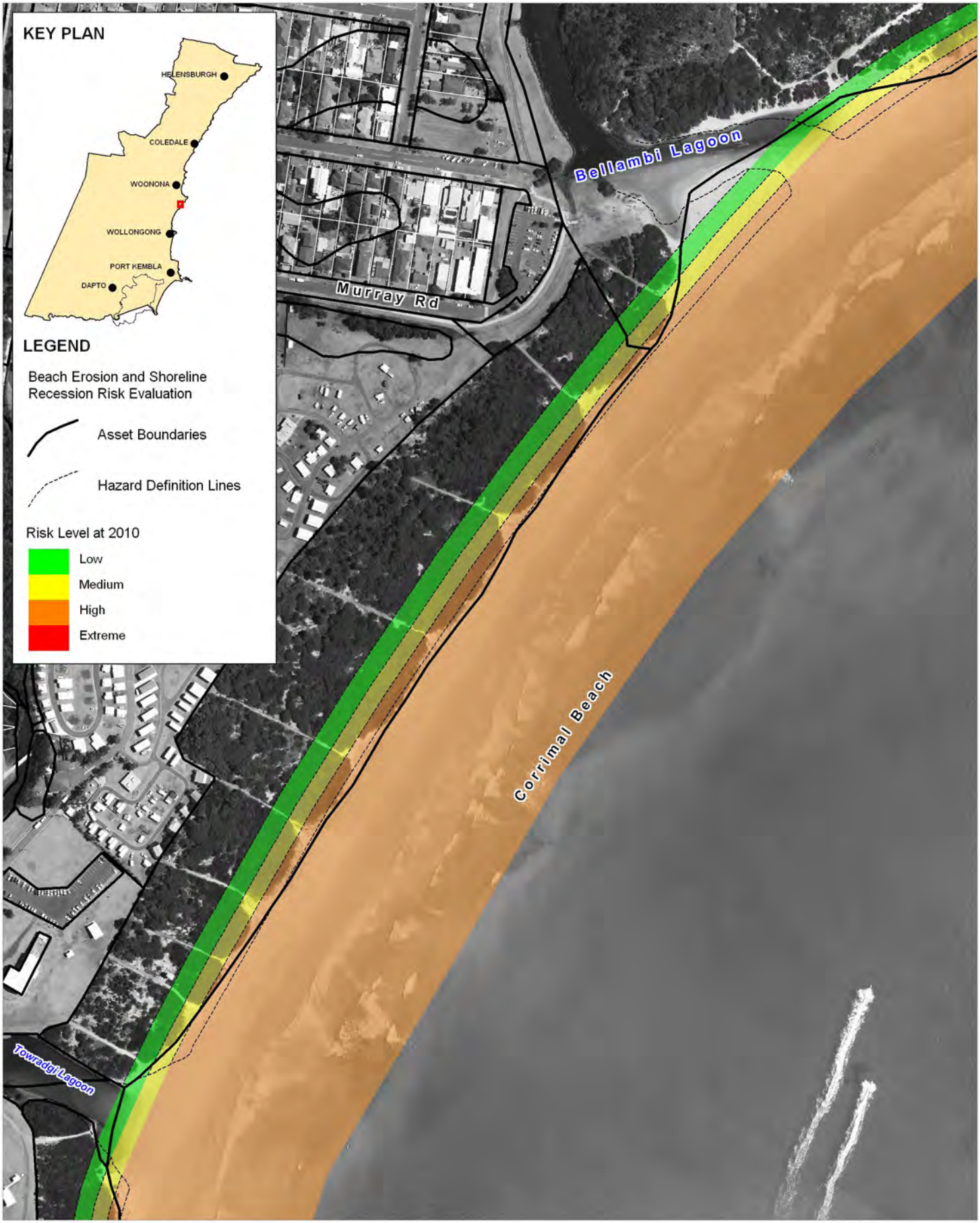
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_114_110414 Drawing A-14.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Corrimal Beach

Drawing: A-15

Rev: A

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N

0 75 150m

Approx. Scale

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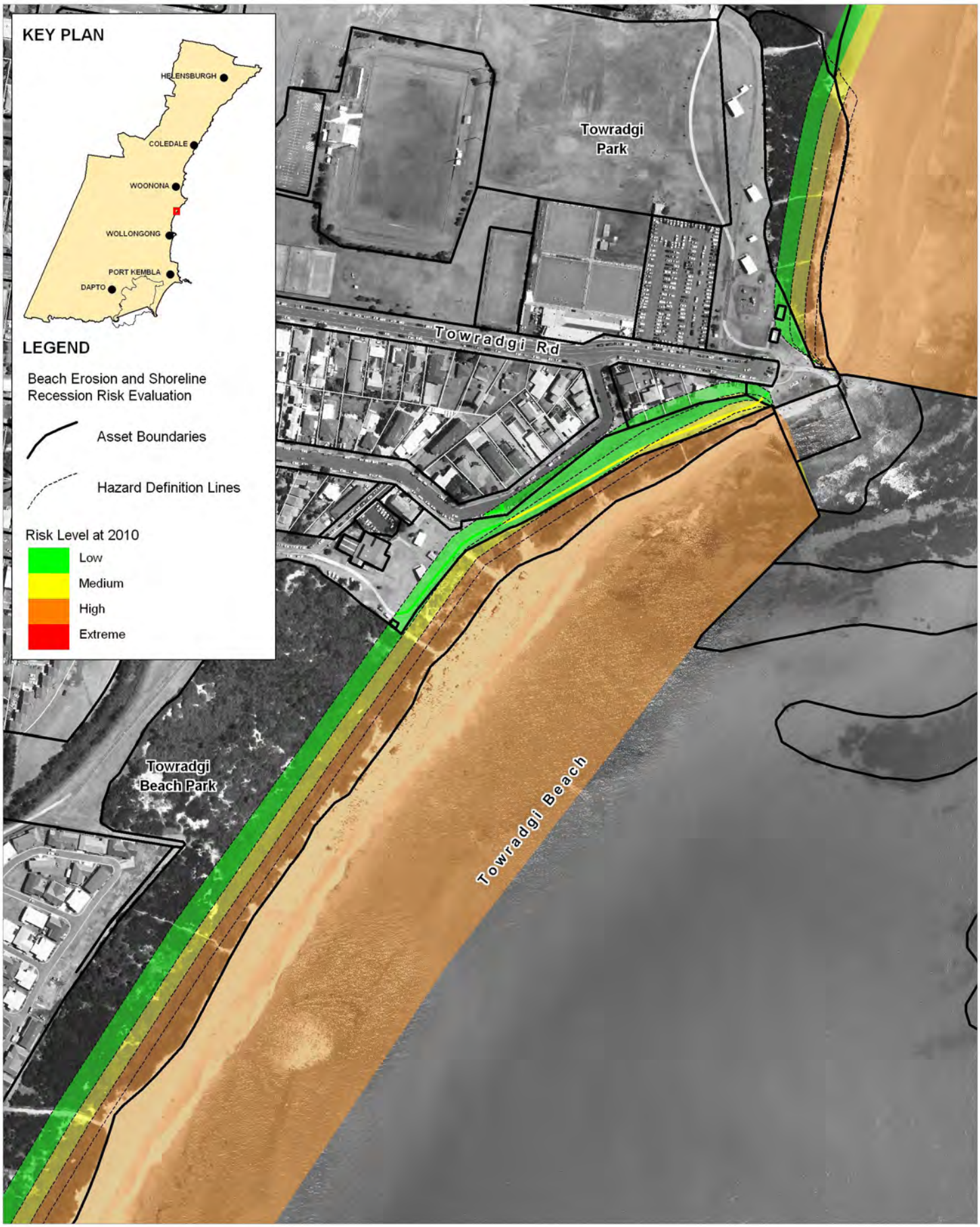

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Towradgi Beach

Drawing: A-16

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
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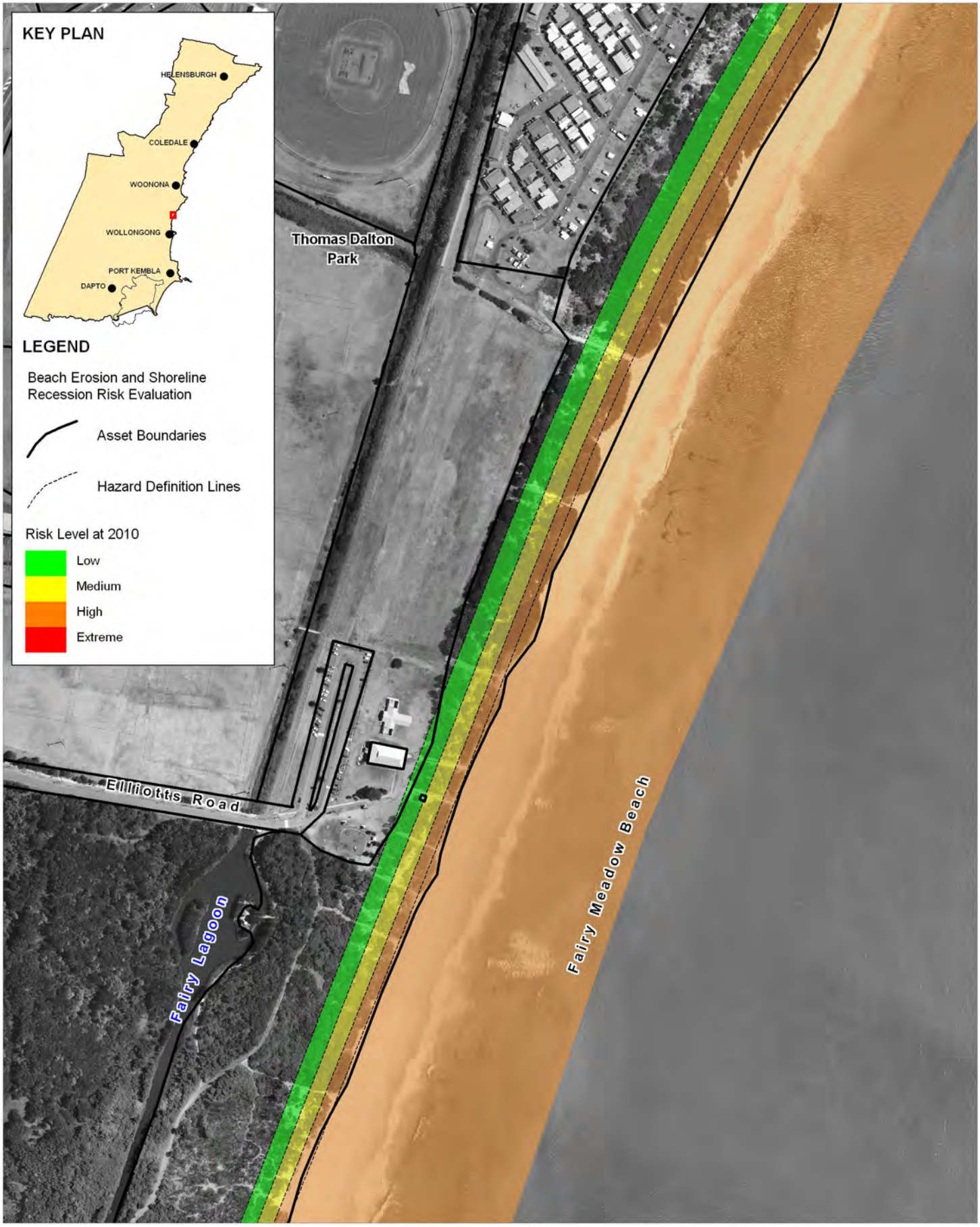

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Fairy Meadow Beach (north)

Drawing: A-17

Rev: A

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N

0 75 150m

Approx. Scale

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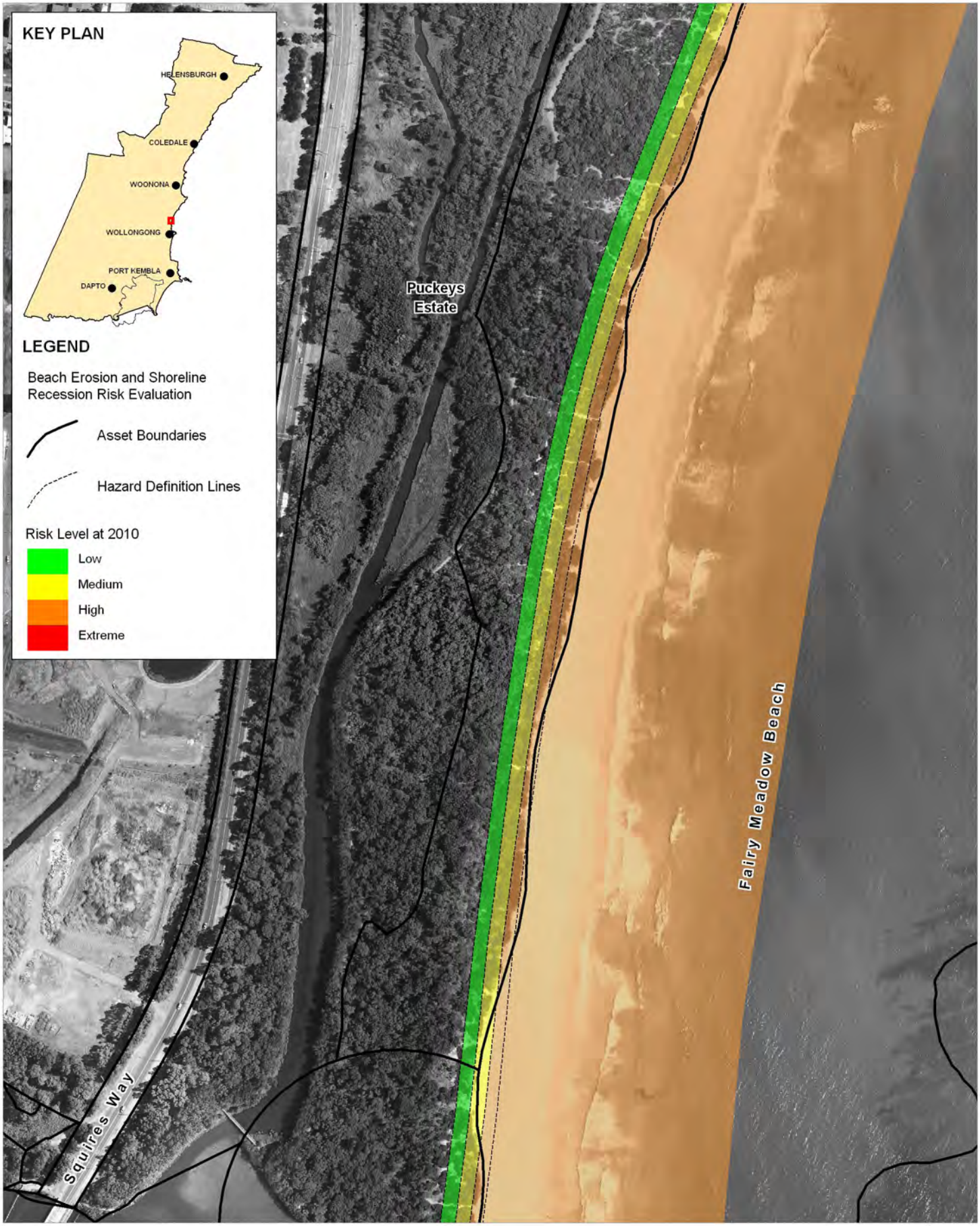
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_117_110415 Drawing A-17.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Fairy Meadow Beach (south)

Drawing: A-18

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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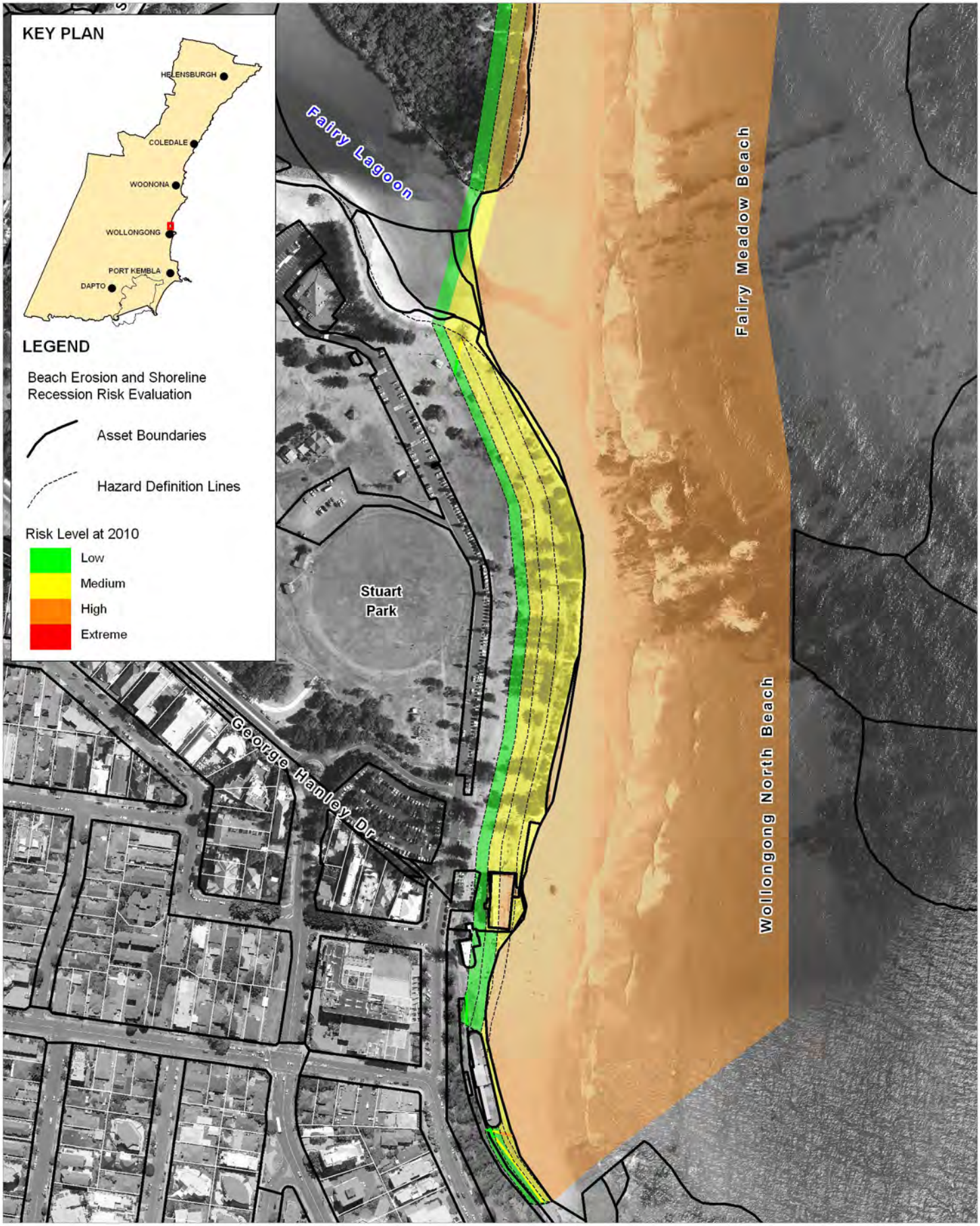
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_118_110415 Drawing A-18.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Wollongong North Beach

Drawing: A-19

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
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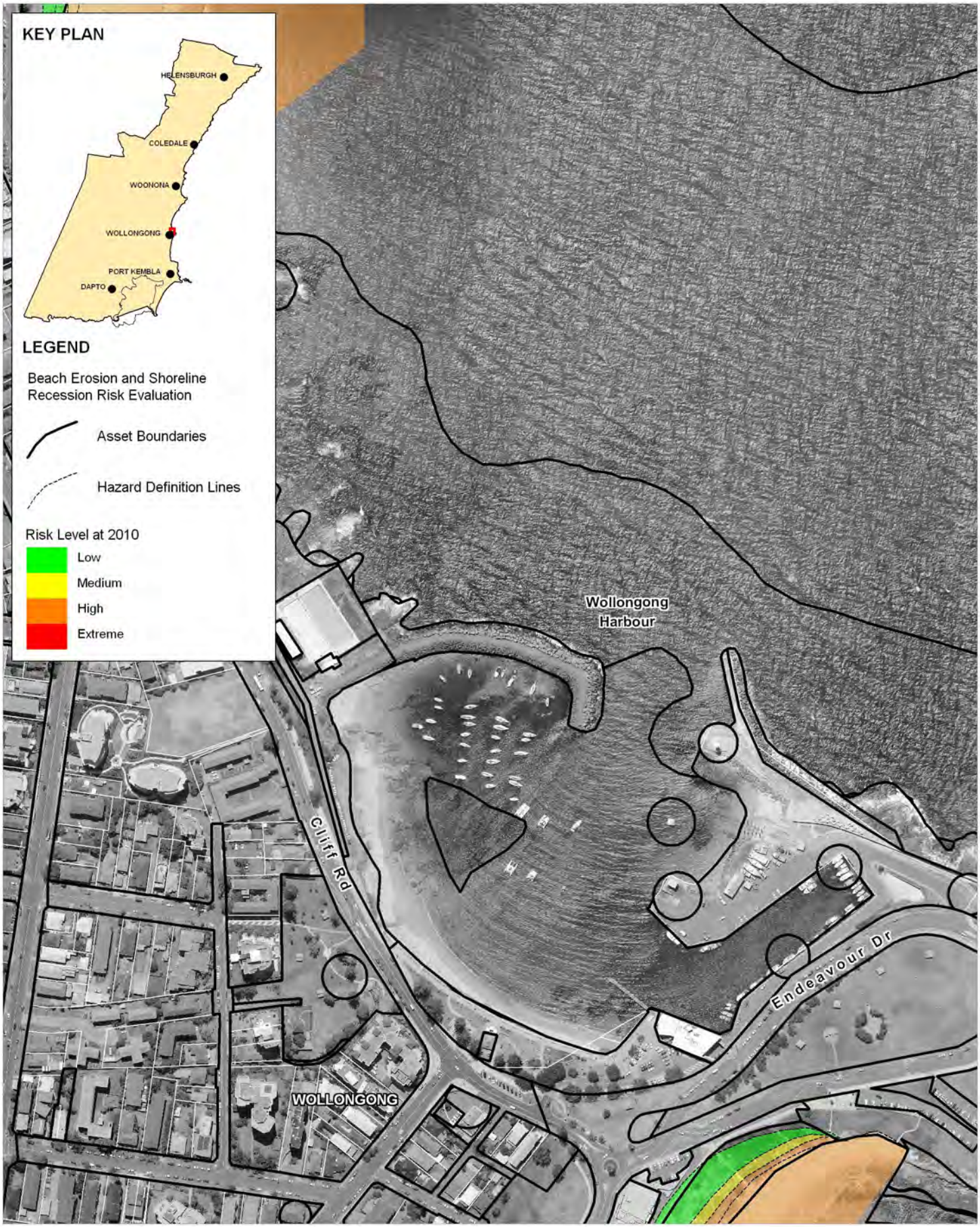
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_119_110415 Drawing A-19.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Wollongong Harbour

Drawing: A-20

Rev: A

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N

0 75 150m

Approx. Scale

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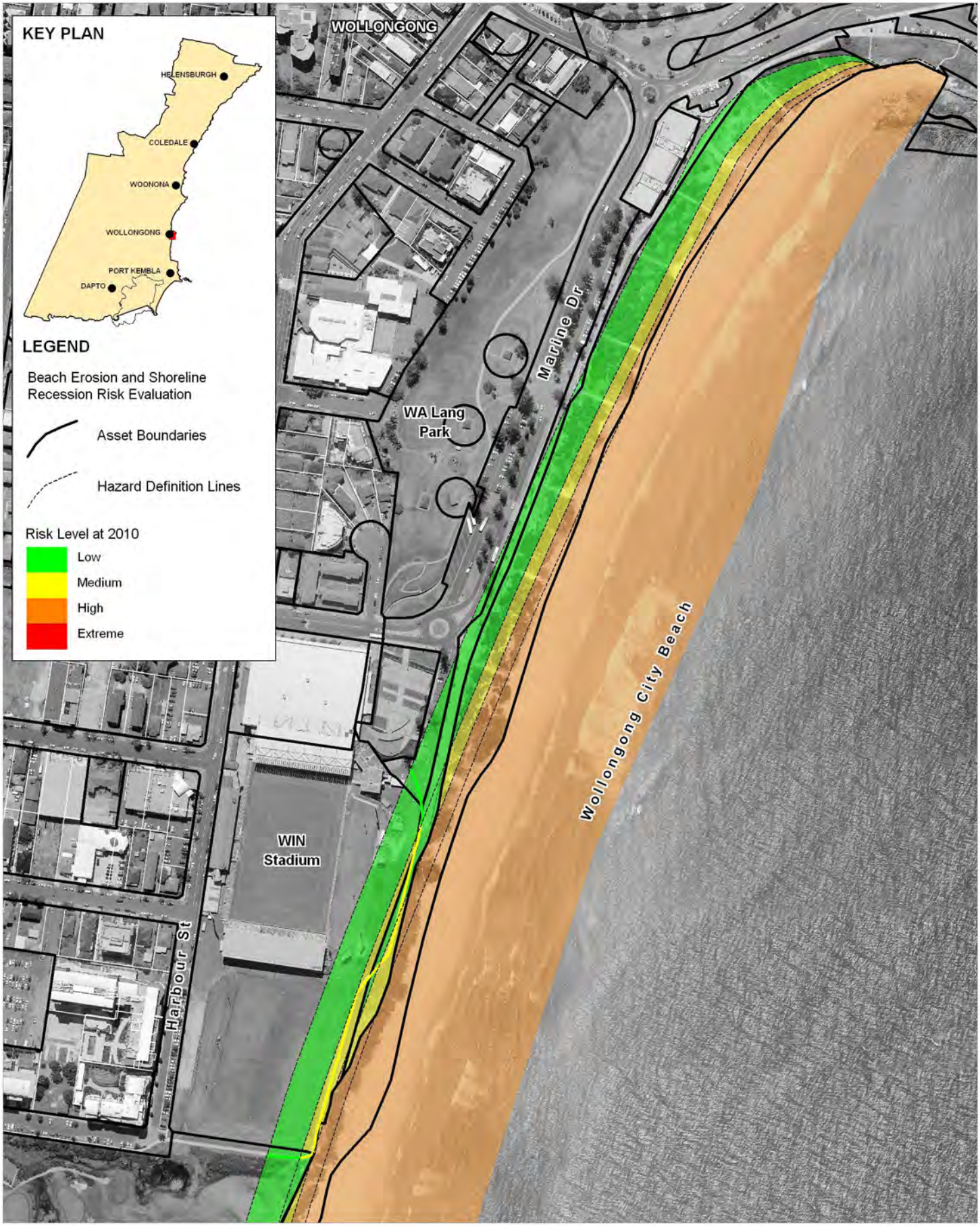

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Wollongong City Beach

Drawing: A-21

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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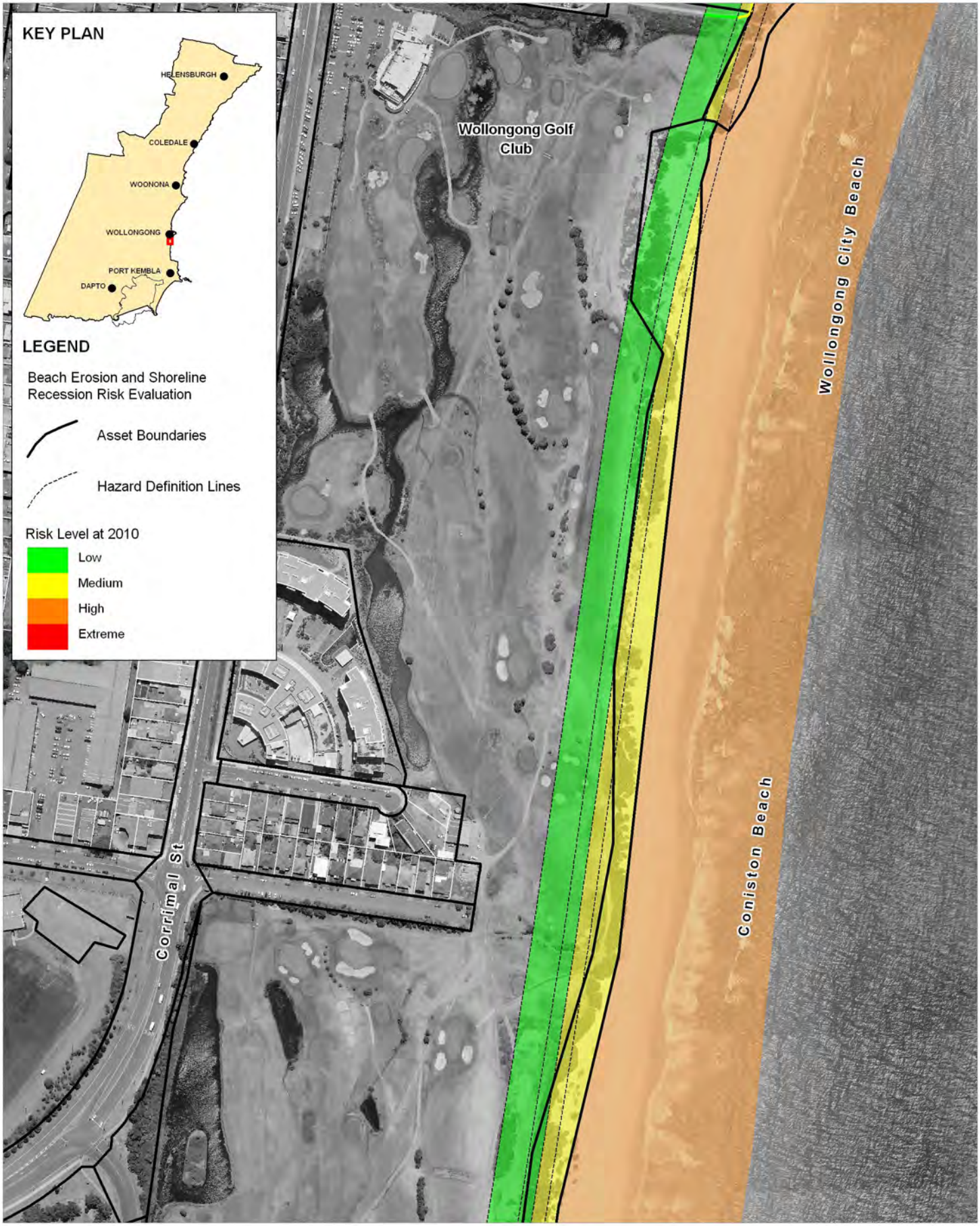

Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Coniston Beach (north)

Drawing: A-22

Rev: A

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N

0 75 150m

Approx. Scale

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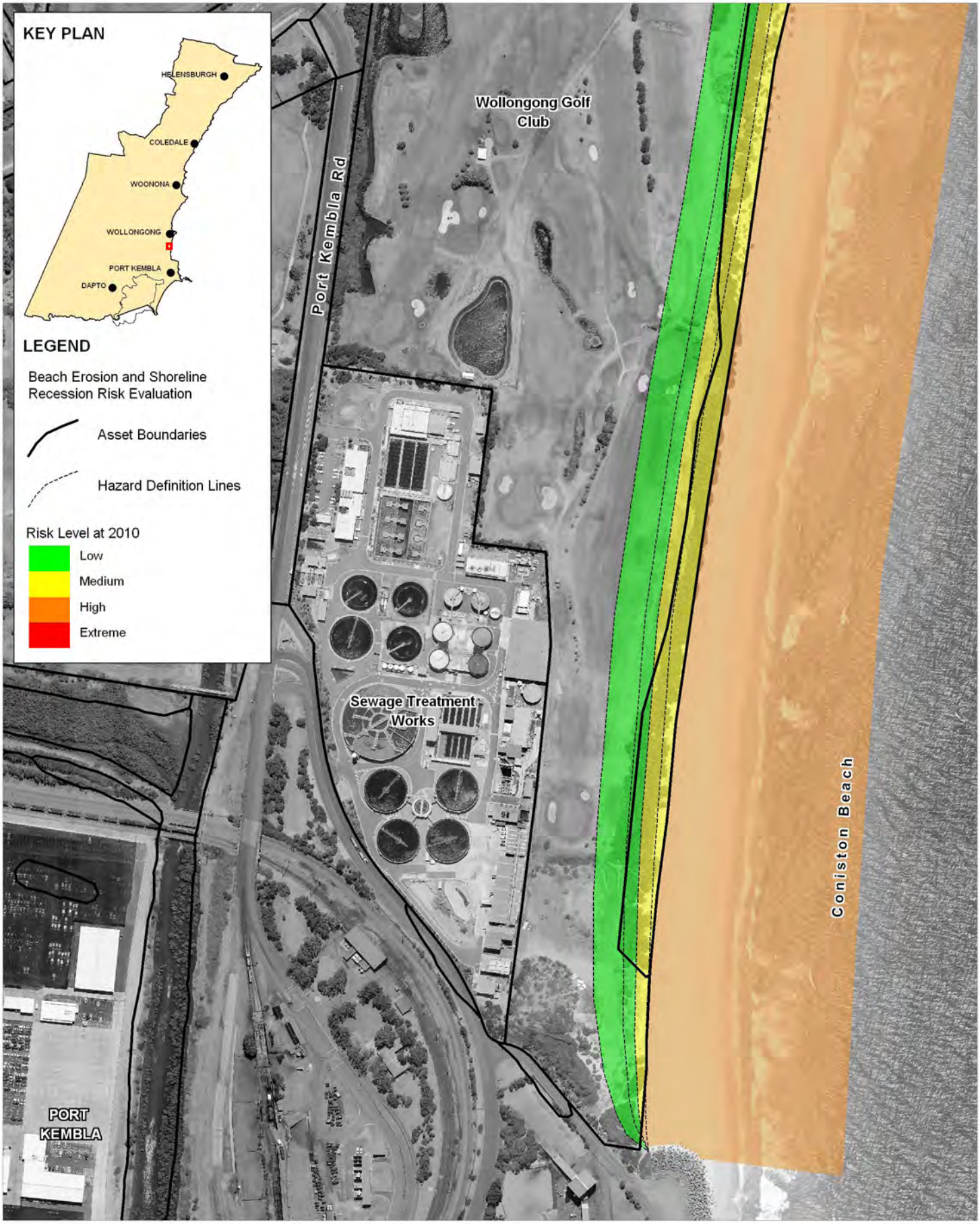
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_122_110415 Drawing A-22.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Coniston Beach (south)

Drawing: A-23

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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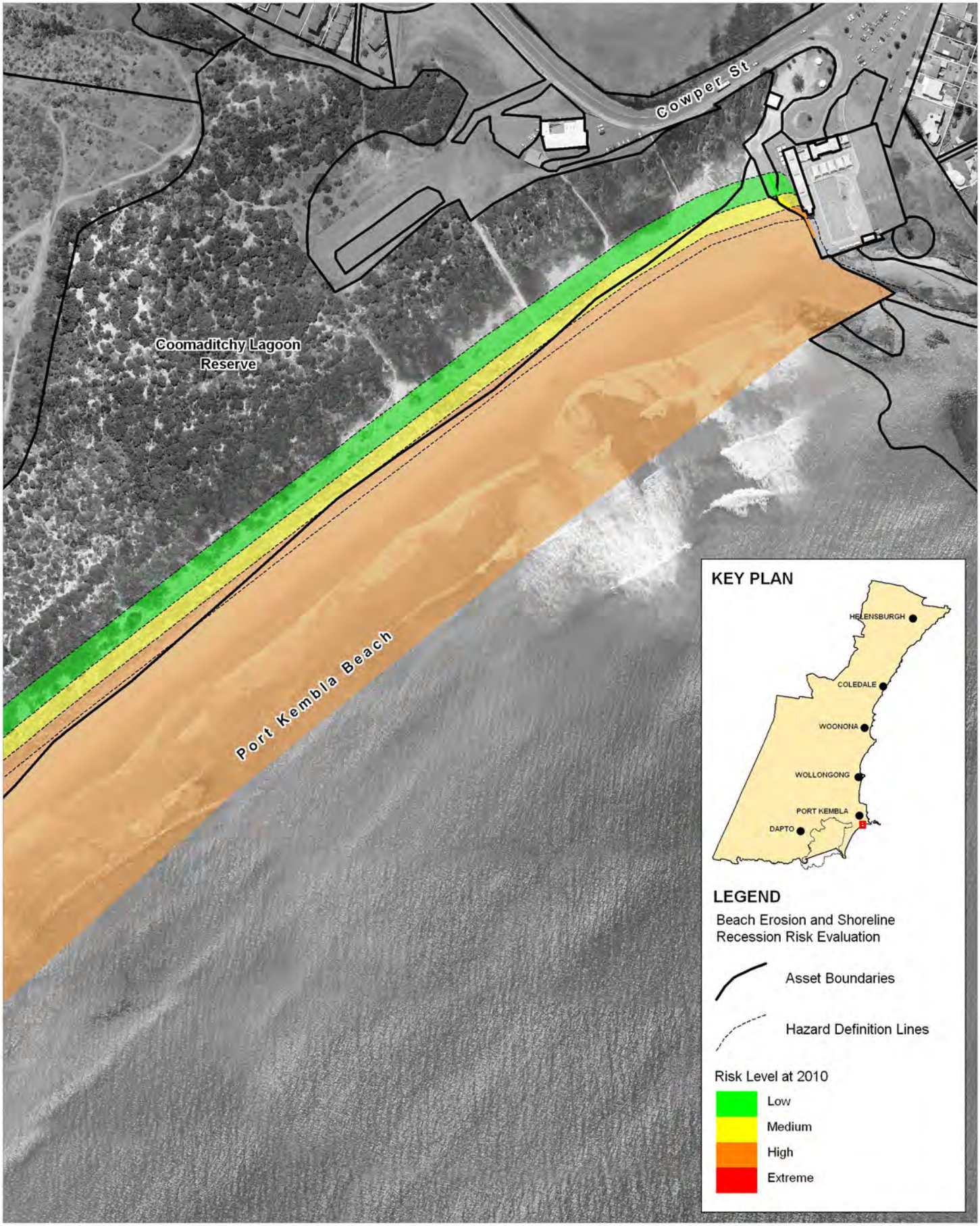
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_123_110415 Drawing A-23.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Port Kembla Beach

Drawing: **A-24**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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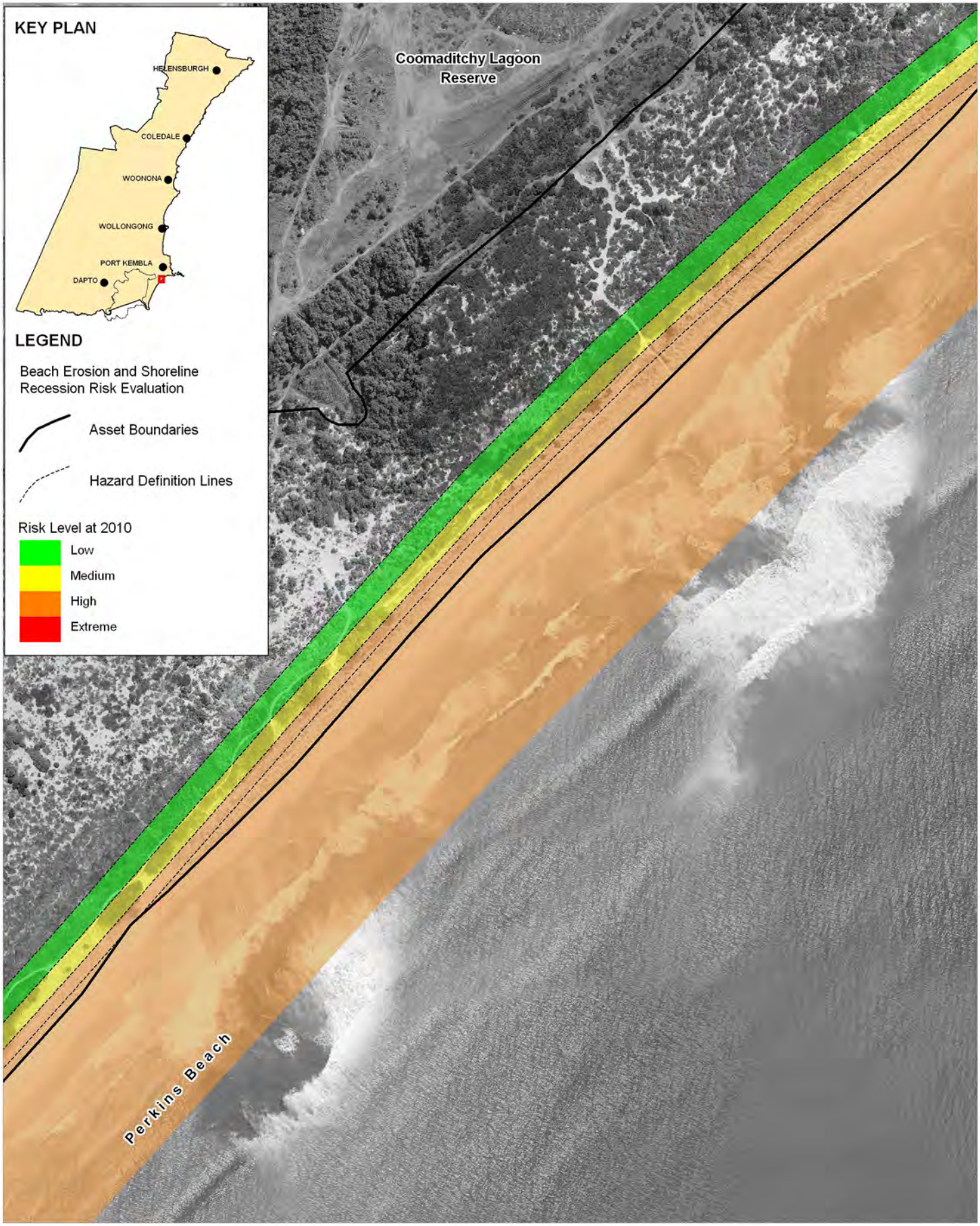
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_124_110415 Drawing A-24.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Perkins Beach (1)

Drawing: A-25

Rev: A

N

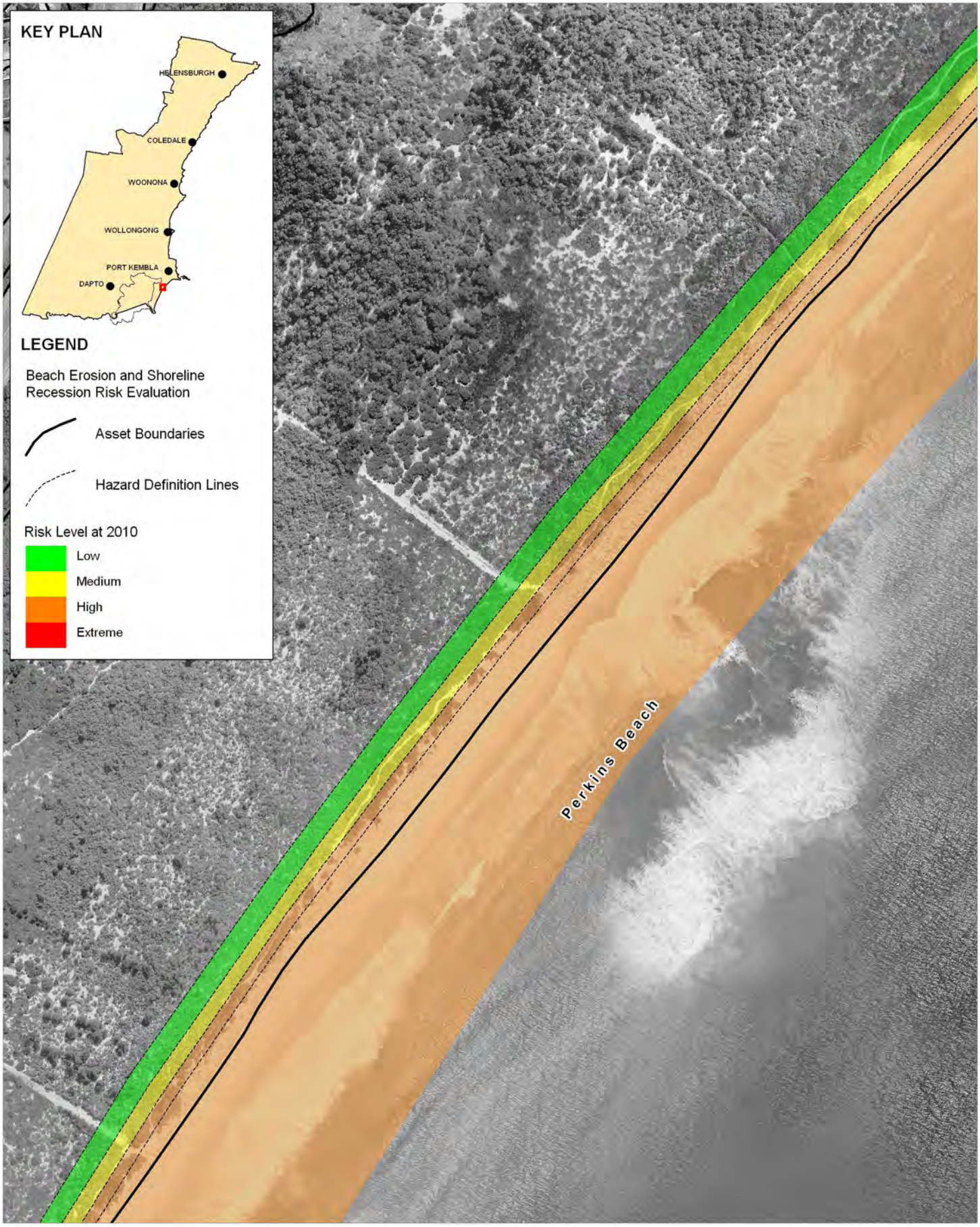
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_125_110415 Drawing A-25.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Perkins Beach (2)

Drawing: A-26

Rev: A

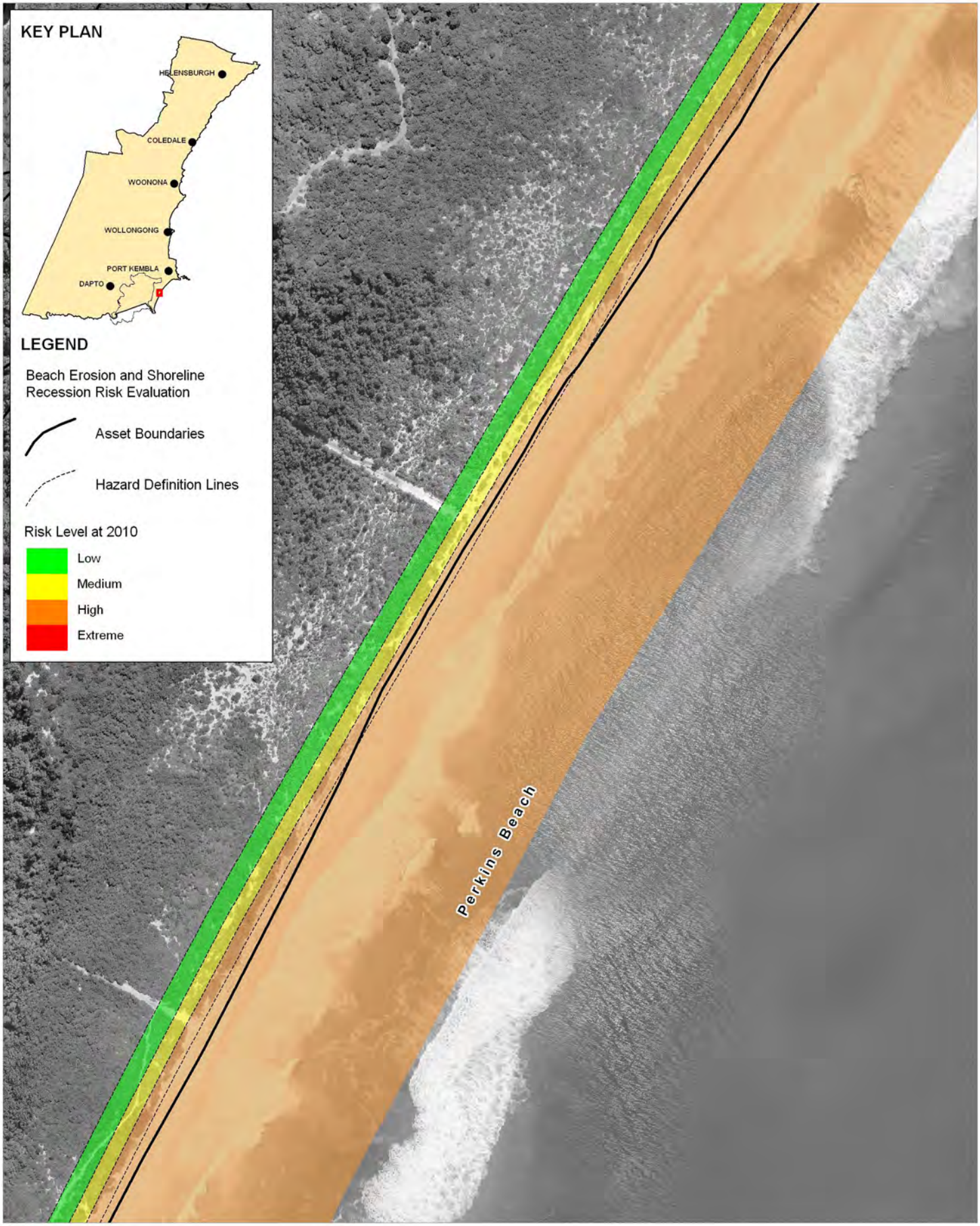
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_126_110415 Drawing A-26.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Perkins Beach (3)

Drawing: **A-27**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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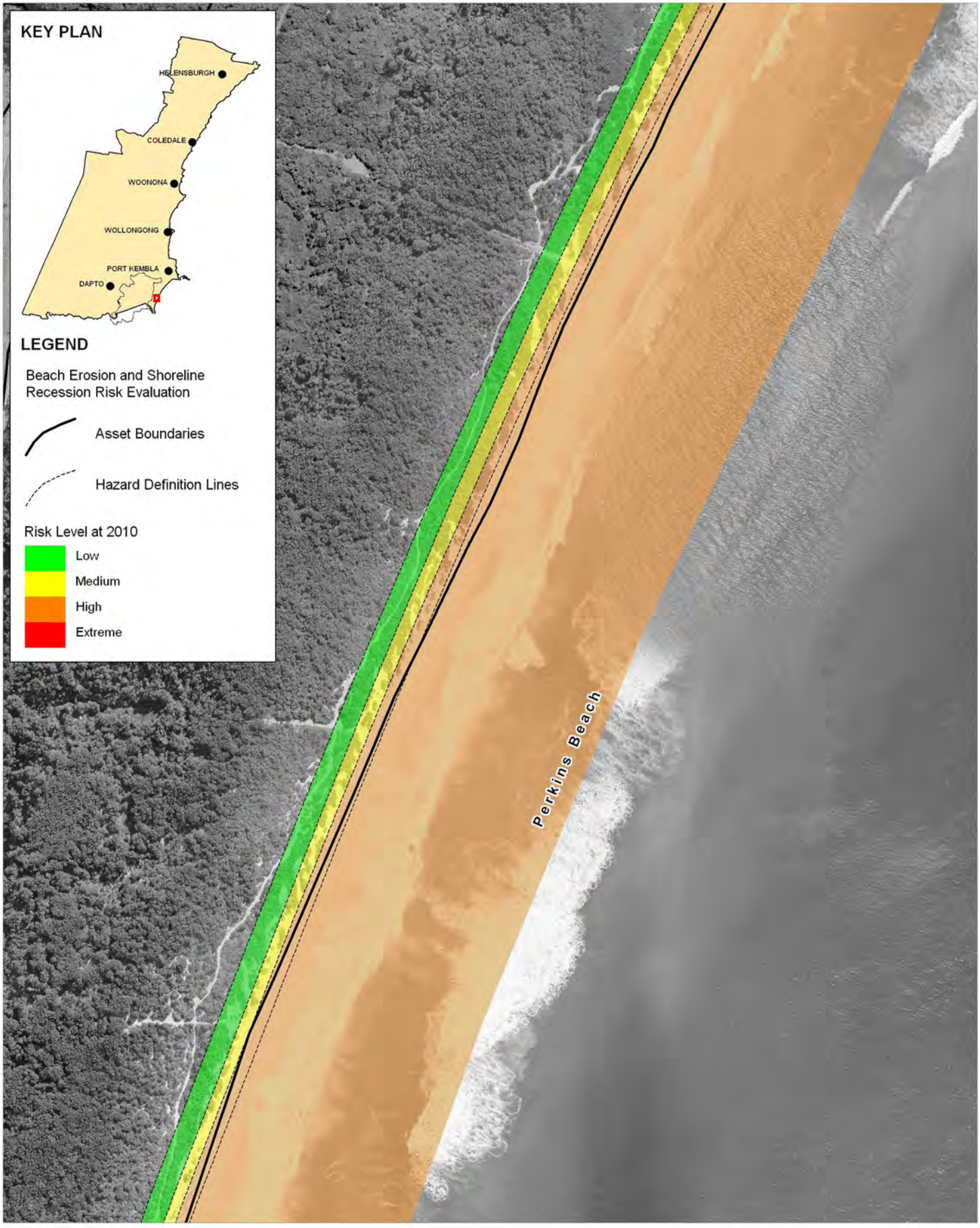
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_127_110415 Drawing A-27.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Perkins Beach (4)

Drawing: **A-28**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM

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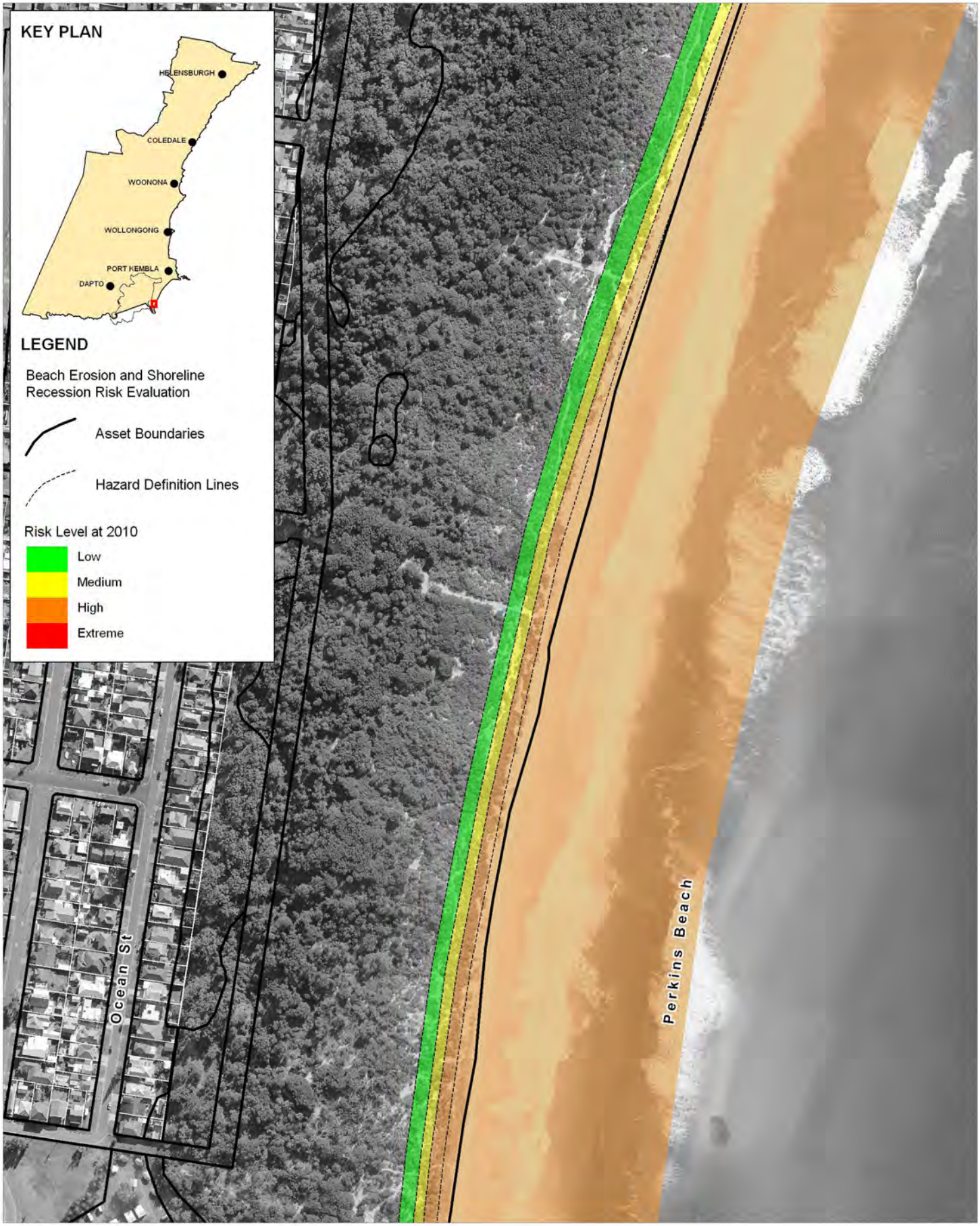
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_128_110415 Drawing A-28.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Perkins Beach (5)

Drawing: A-29

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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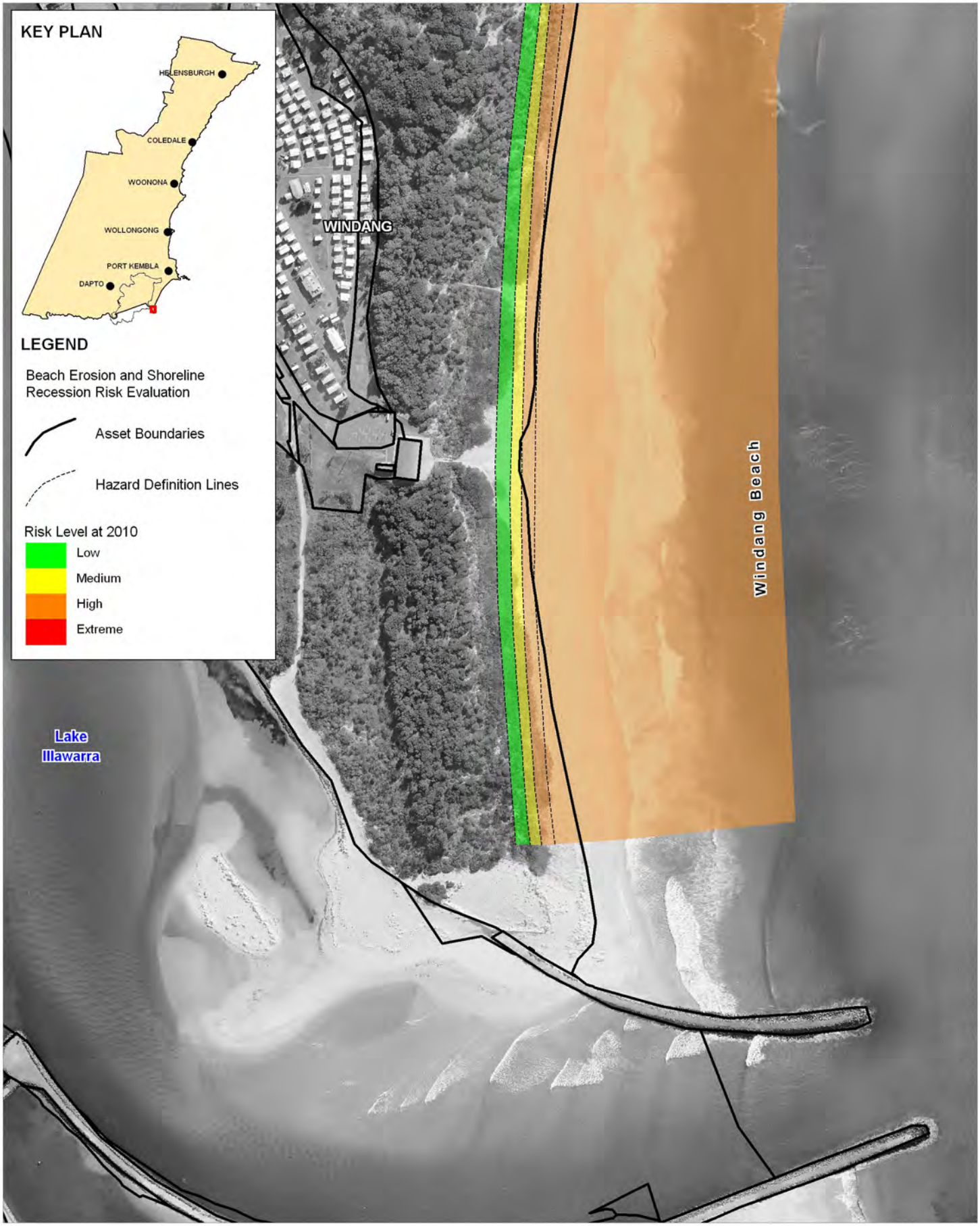
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_129_110415 Drawing A-29.WOR



Title:

Erosion and Recession Risk Evaluation
Immediate Planning Horizon - Windang Beach

Drawing: A-30

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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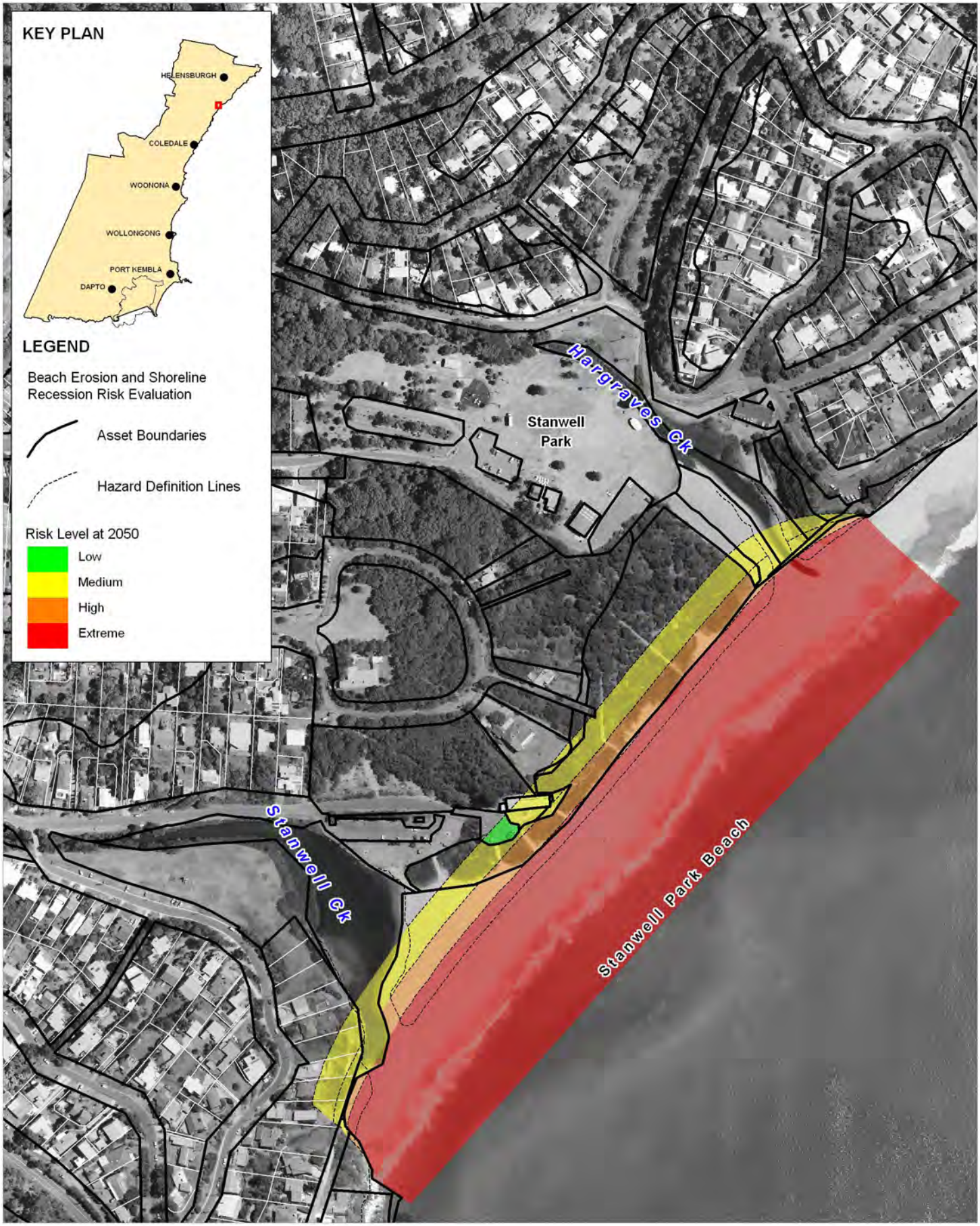
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_130_110415 Drawing A-30.WOR



Title:

Erosion and recession Risk Evaluation 2050 Planning Horizon - Stanwell Park

Drawing: B-1

Rev: A

N

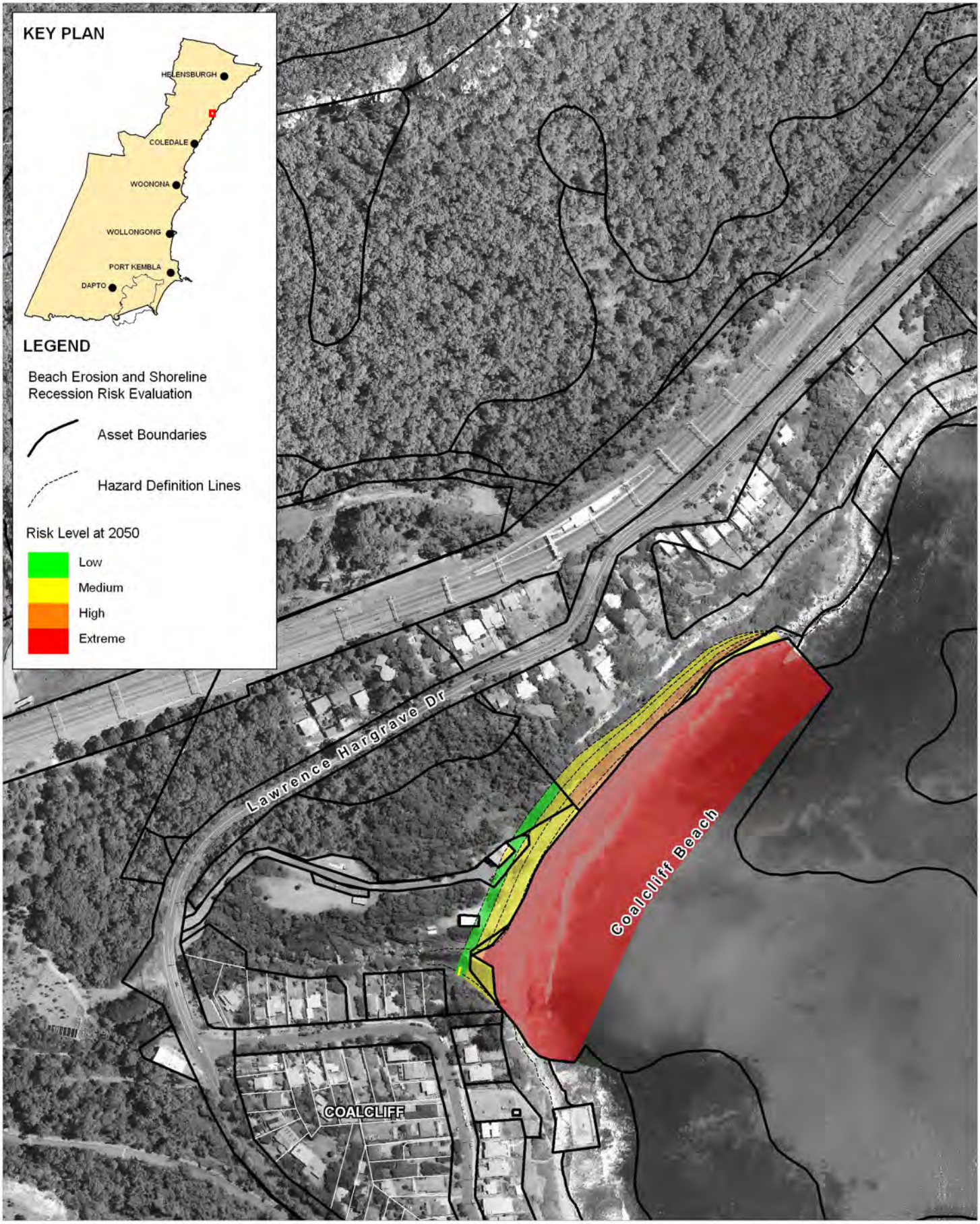
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_131_110415 Drawing B-1.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Coalcliff

Drawing: **B-2**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 75 150m

Approx. Scale

BMT WBM
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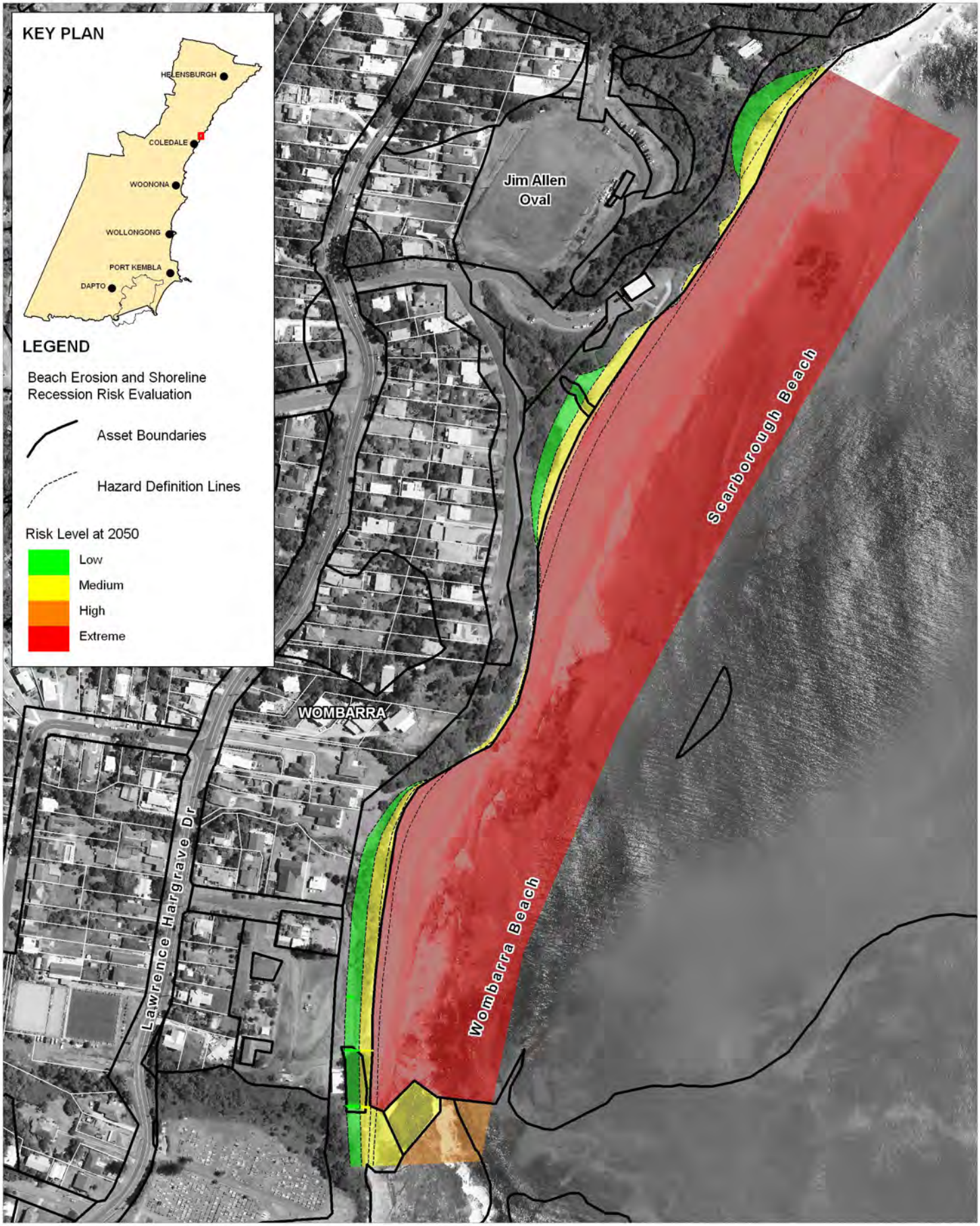
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_132_110415 Drawing B-2.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Scarborough/Wombarra

Drawing: B-3

Rev: A

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N

0 75 150m

Approx. Scale

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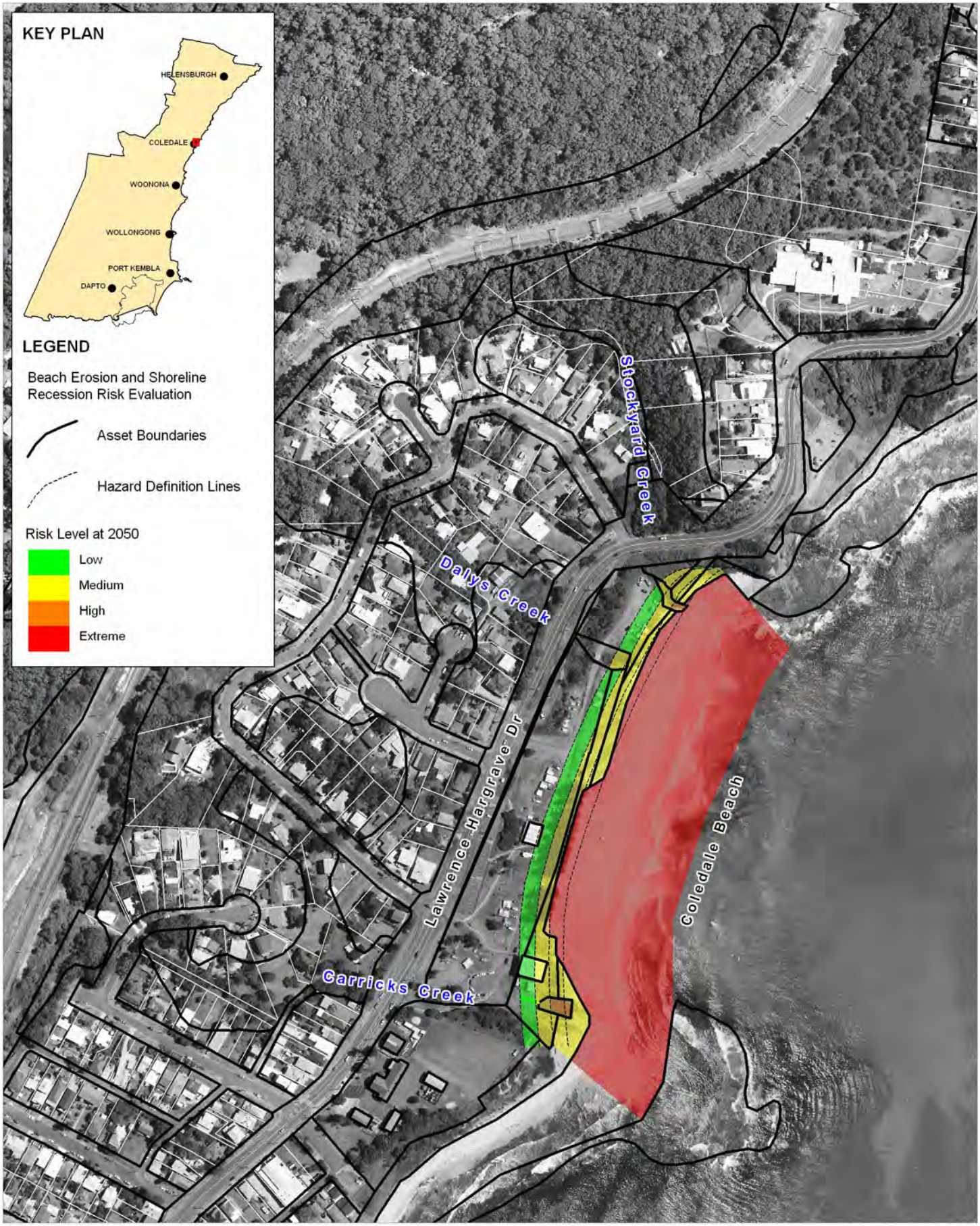

Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Coledale

Drawing: B-4

Rev: A

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N

0 75 150m

Approx. Scale

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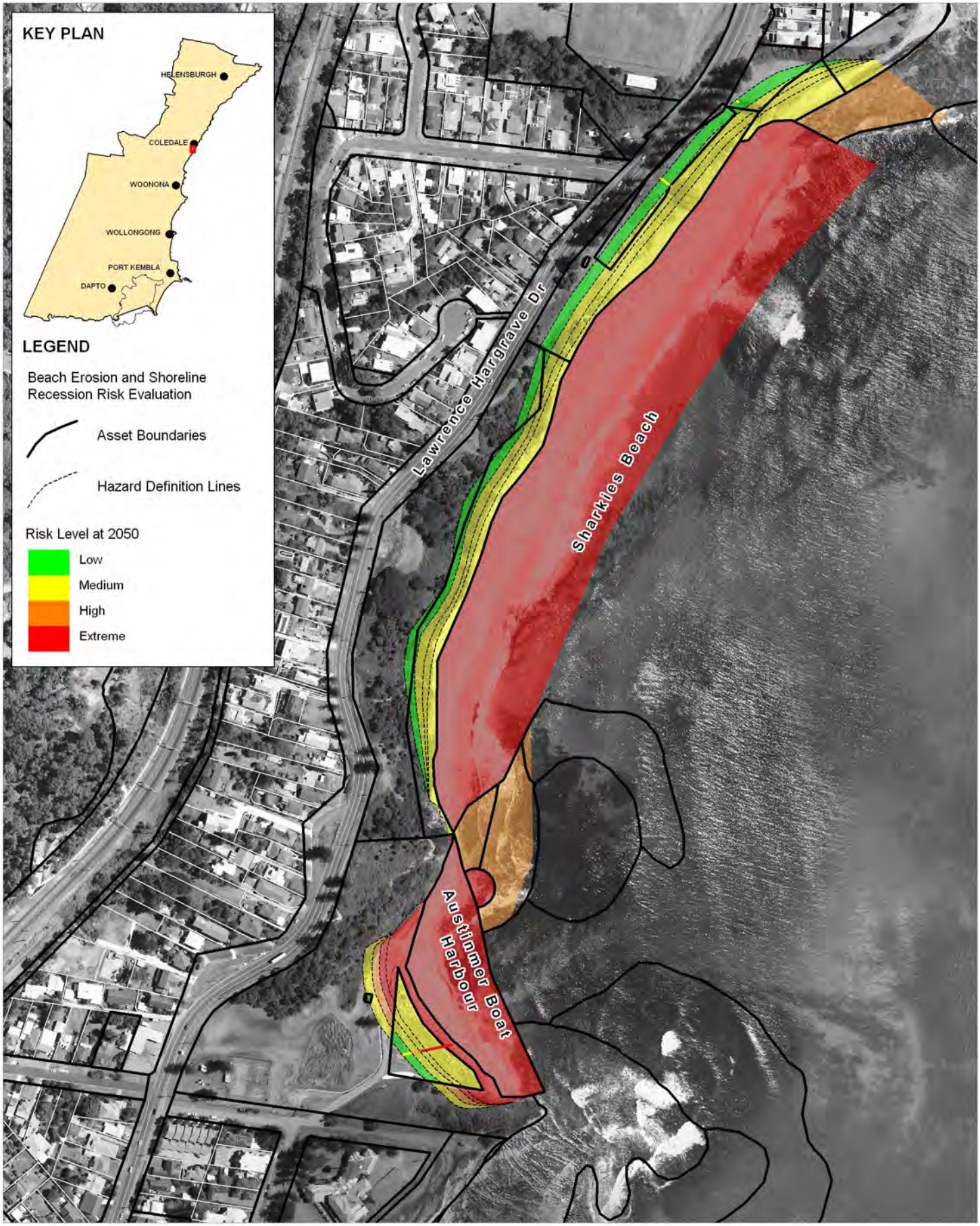
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_134_110415 Drawing B-4.WOR



Title:

Erosion and Recession Risk Evaluation 2050 Planning Horizon - Sharkies Beach

Drawing: B-5

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM

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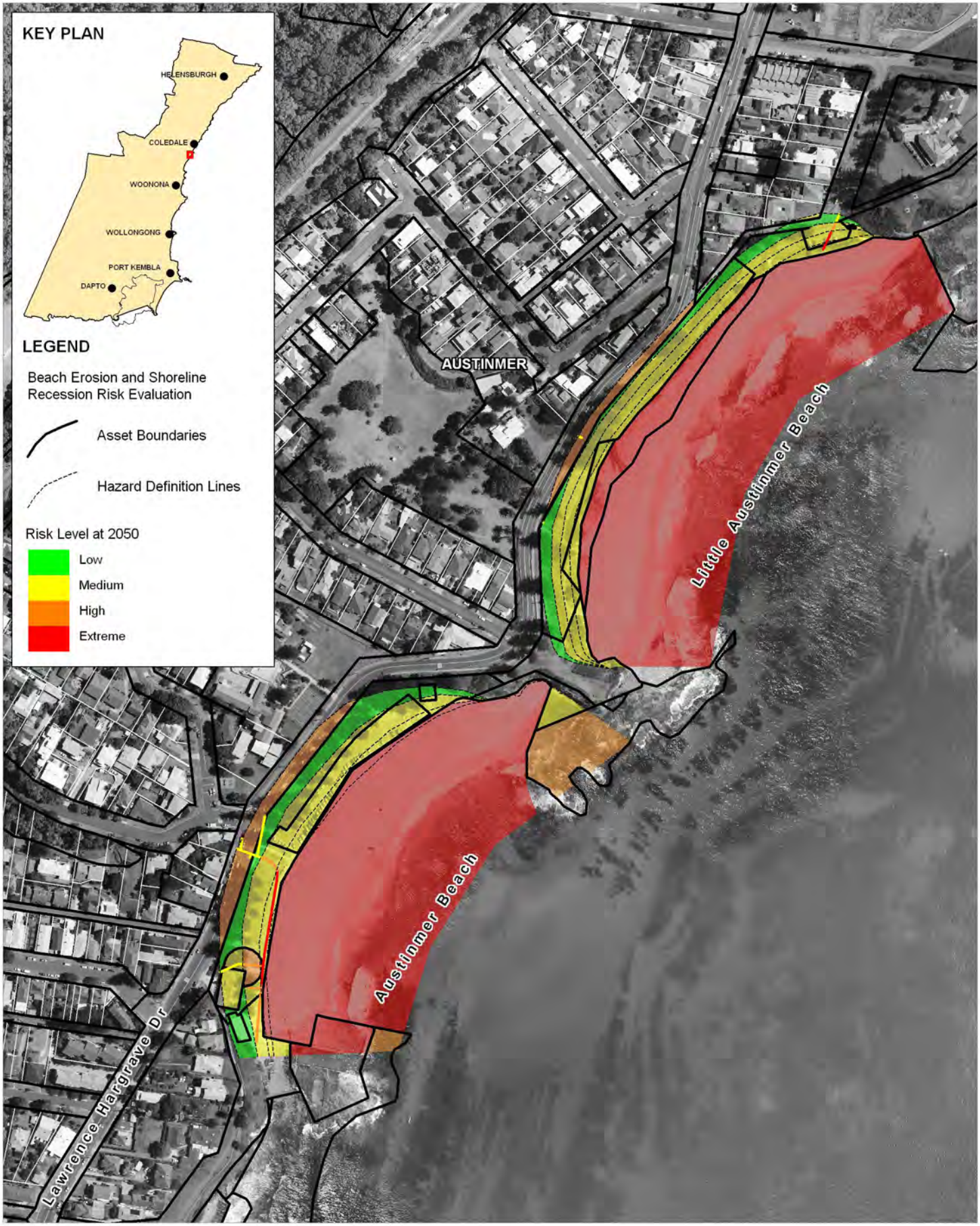
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_135_110415 Drawing B-5.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Austinmer

Drawing: **B-6**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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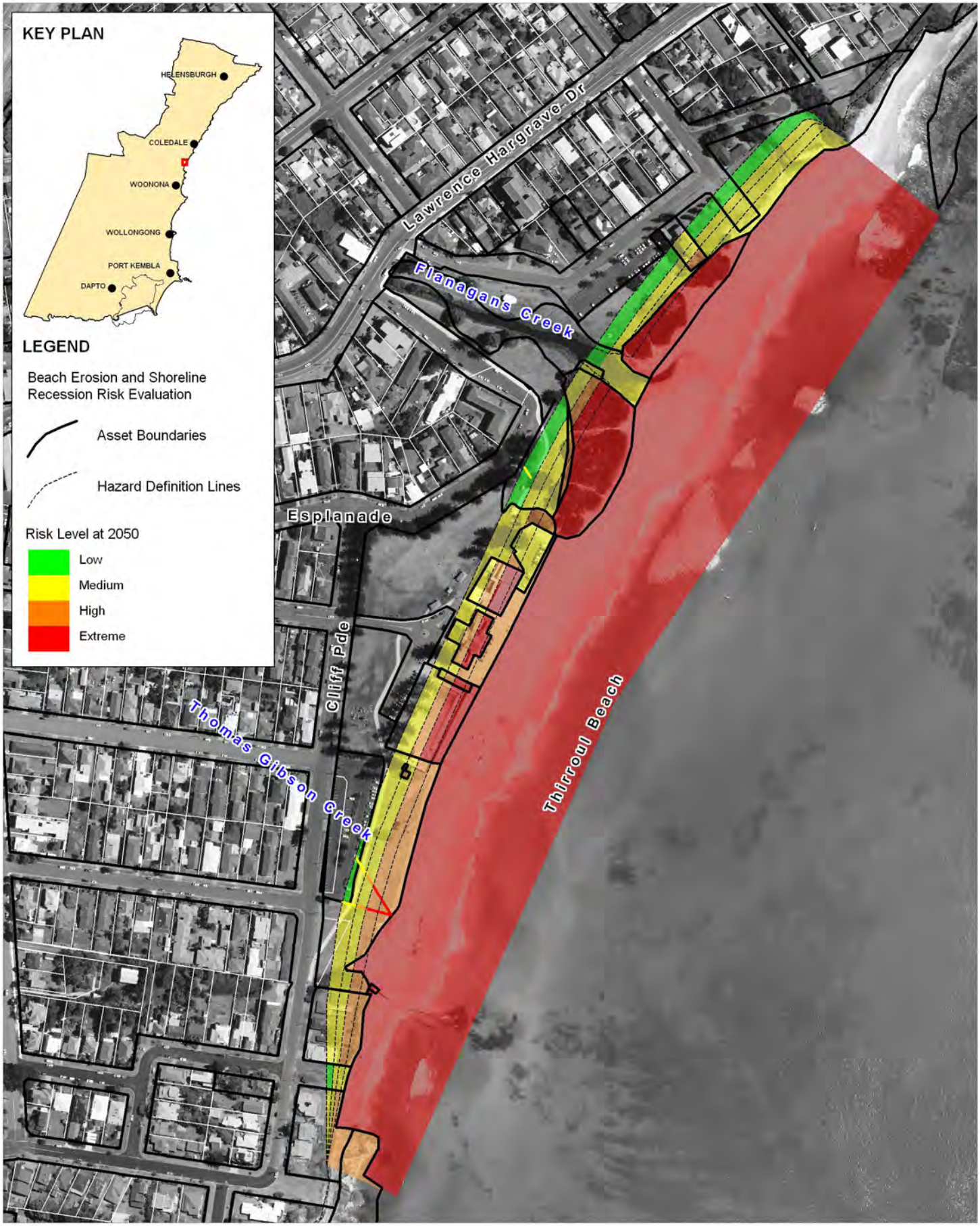
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_136_110415 Drawing B-6.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Thirroul

Drawing: B-7

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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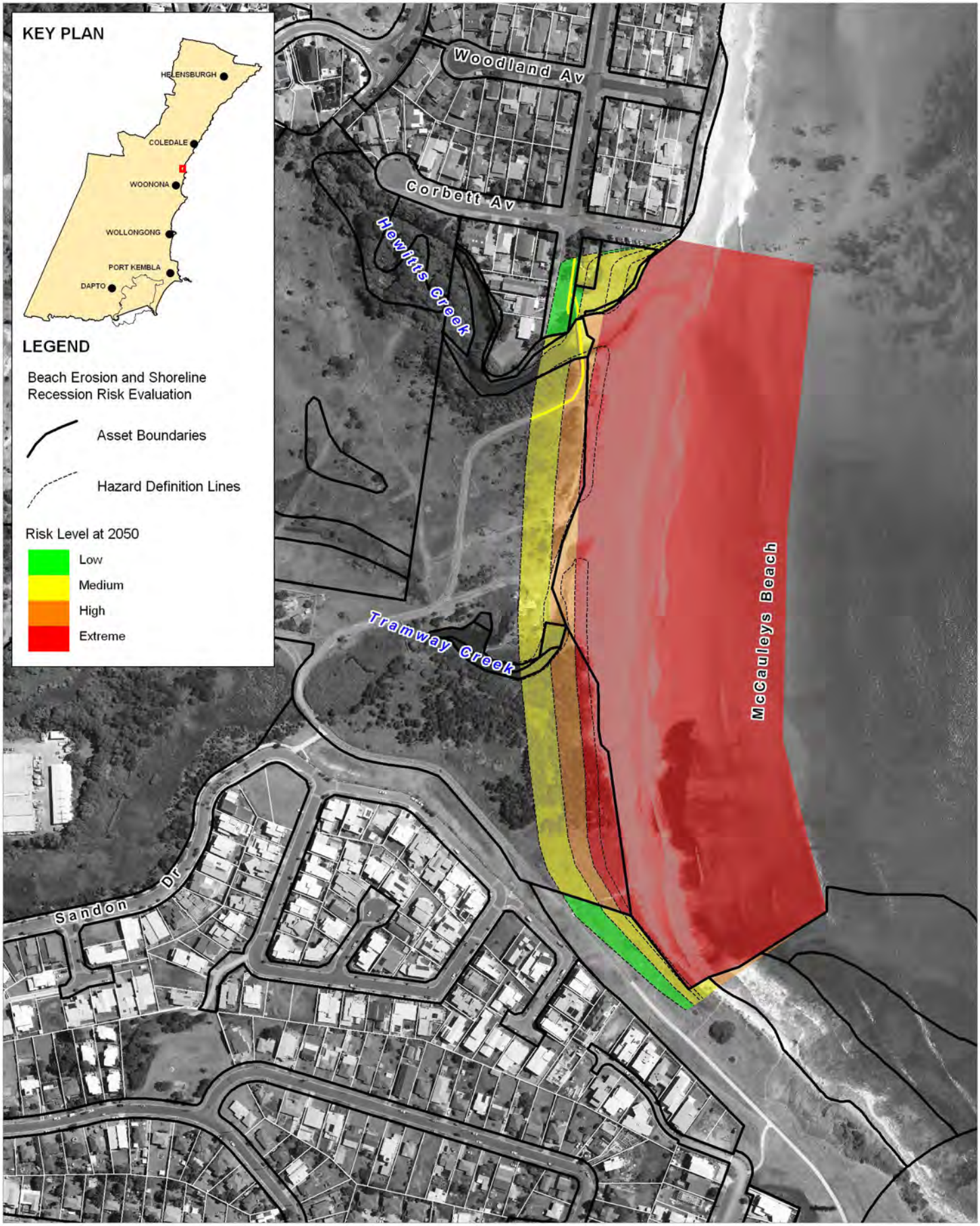
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_137_110414 Drawing B-7.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - McCauleys Beach

Drawing: **B-8**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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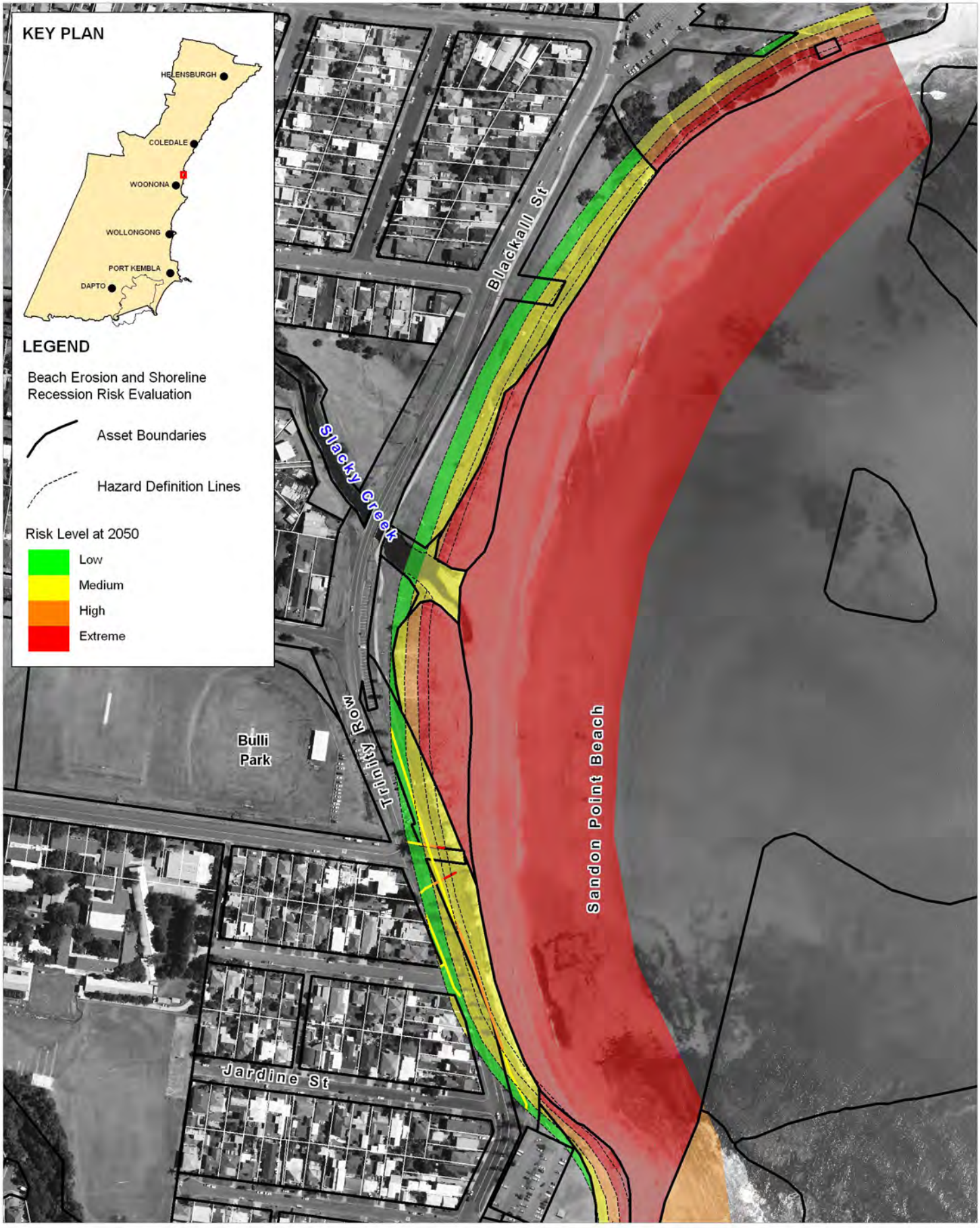
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_138_110415 Drawing B-8.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Sandon Point Beach

Drawing: B-9

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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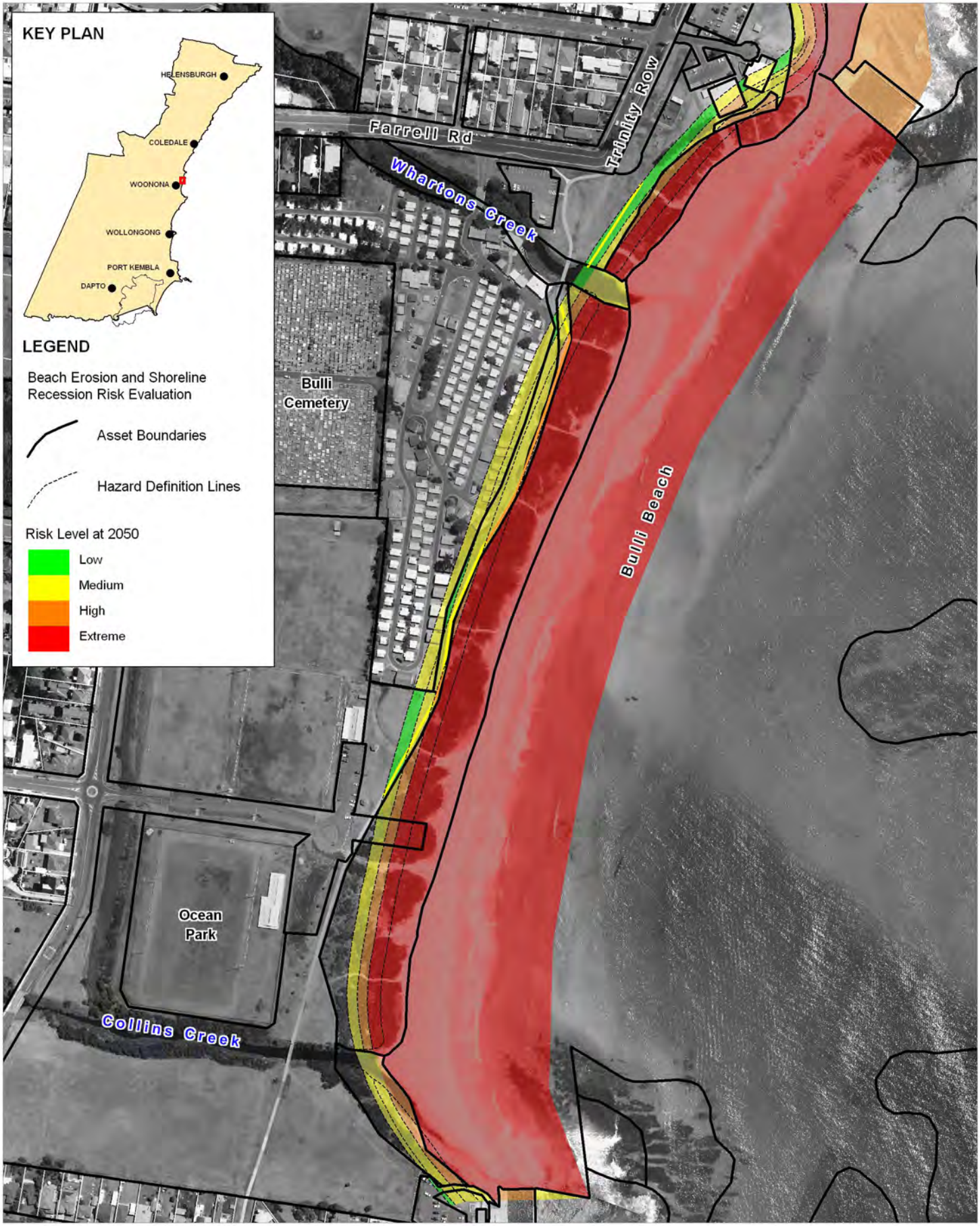
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_139_110415 Drawing B-9.WOR



Title:

Erosion and Recession Risk Evaluation 2050 Planning Horizon - Bulli Beach

Drawing: B-10

Rev: A

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N

0 75 150m

Approx. Scale

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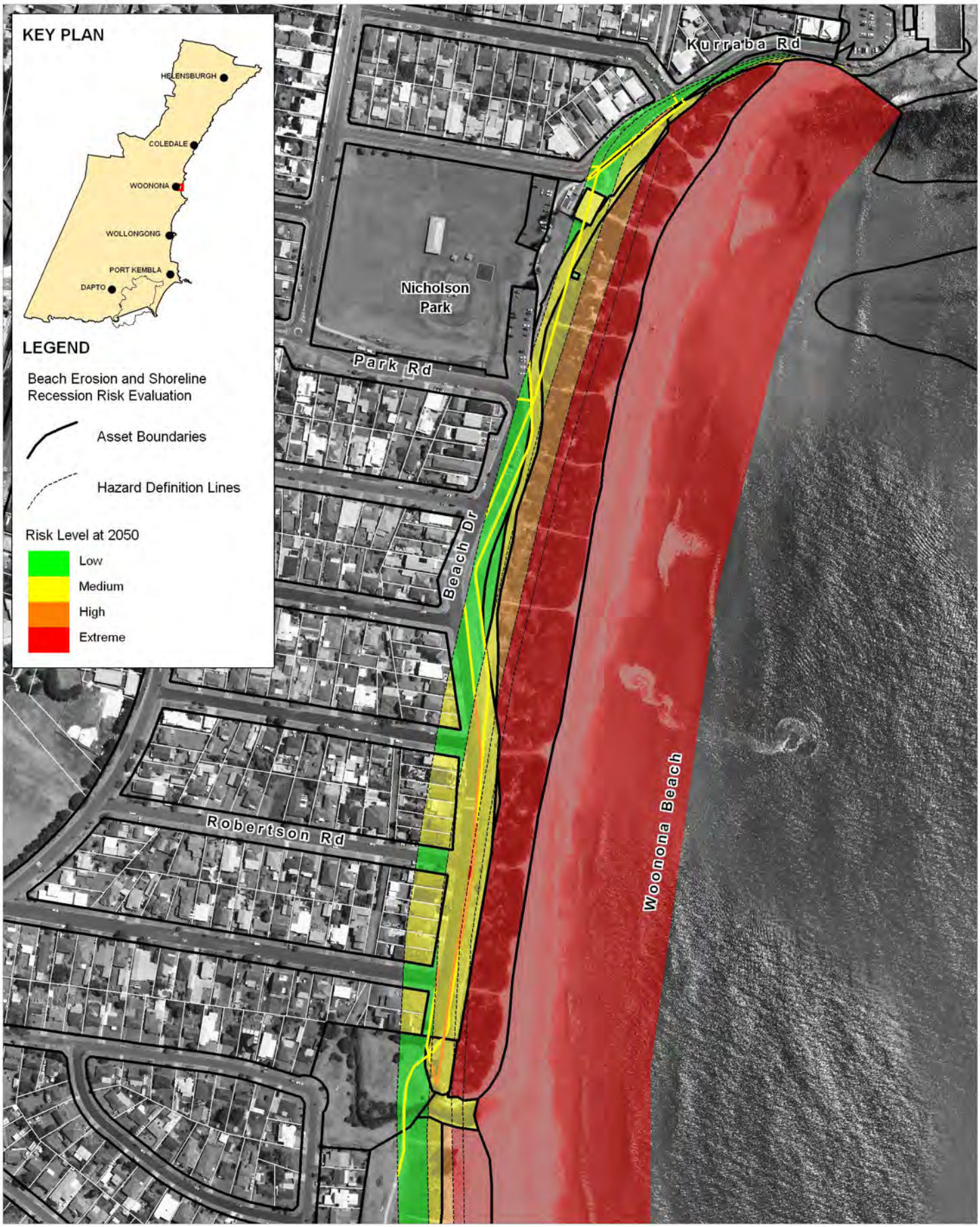
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_140_110415 Drawing B-10.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Woonona Beach

Drawing: B-11

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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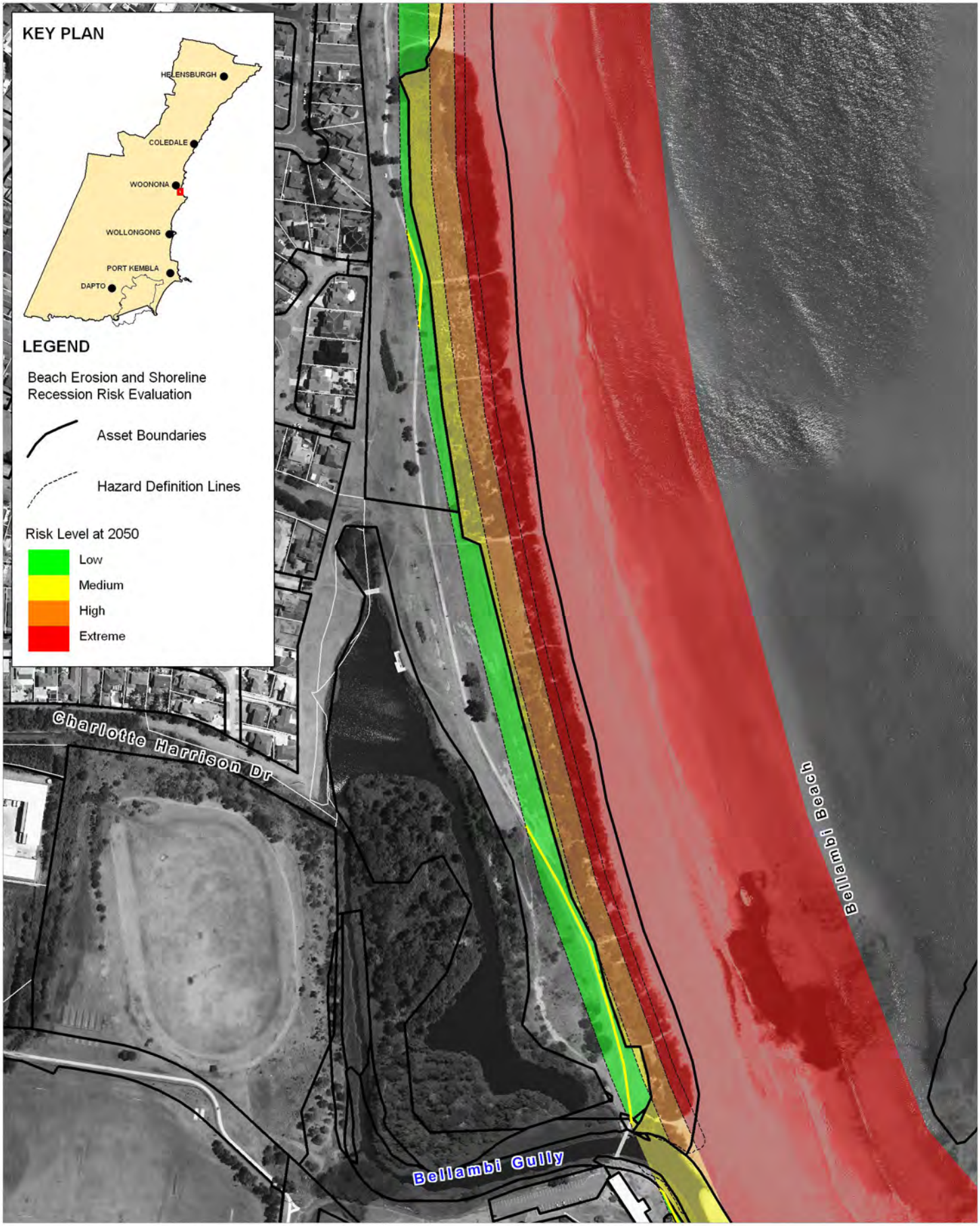
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_141_110415 Drawing B-11.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Bellambi Beach

Drawing: **B-12**

Rev: **A**

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N

0 75 150m

Approx. Scale

BMT WBM
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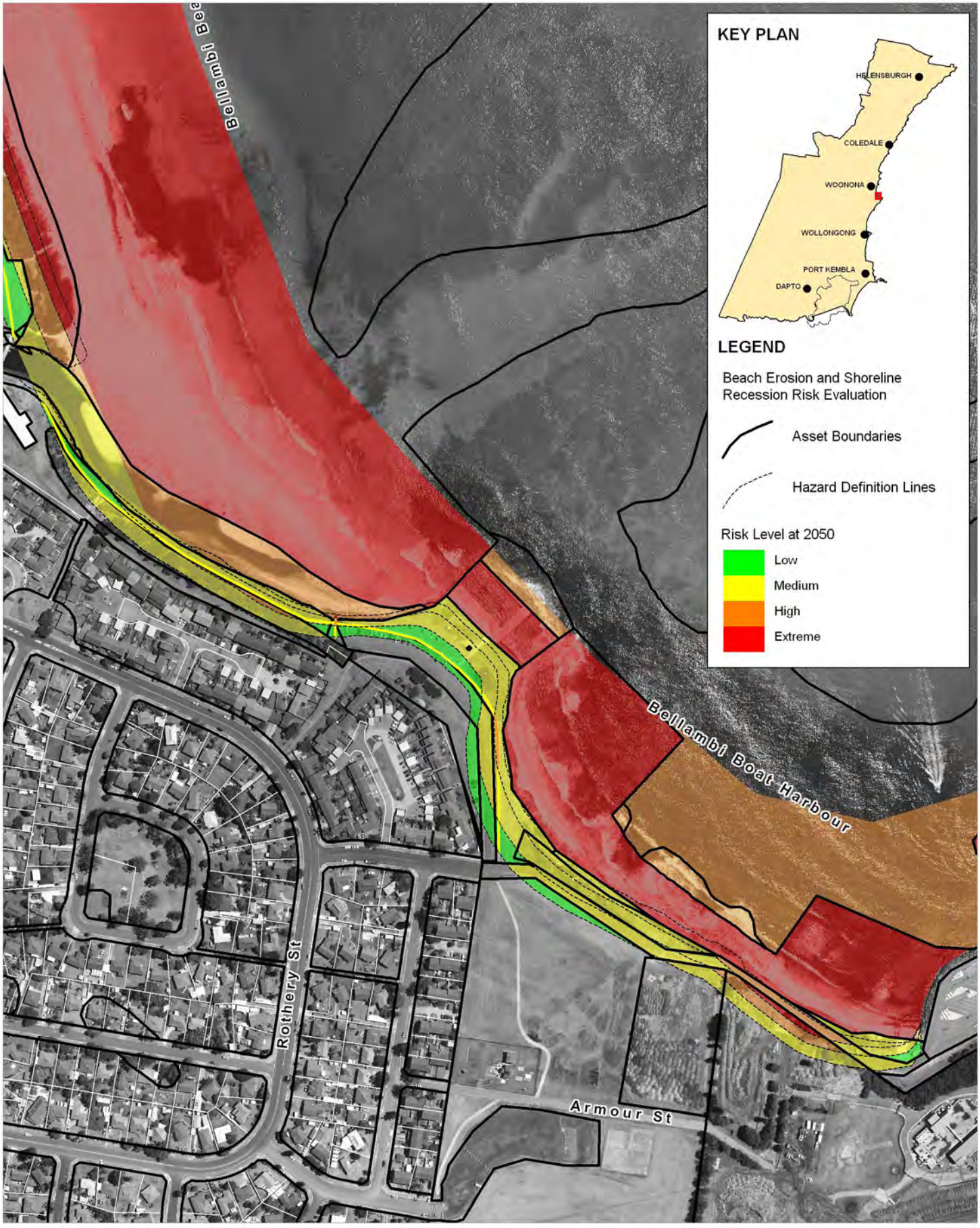
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_142_110414 Drawing B-12.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Bellambi Boat Harbour

Drawing: **B-13**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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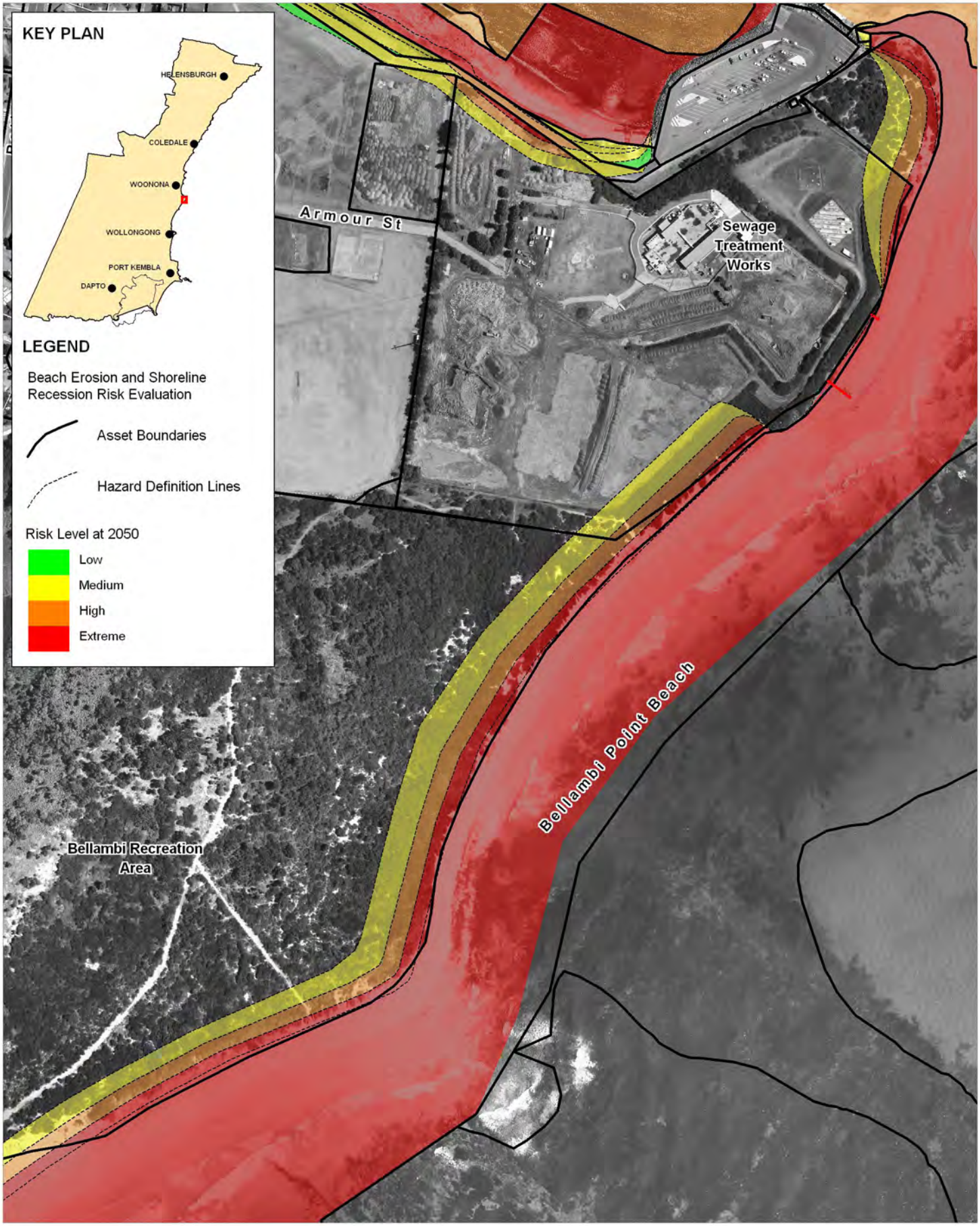
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_143_110415 Drawing B-13.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Bellambi Point Beach

Drawing: **B-14**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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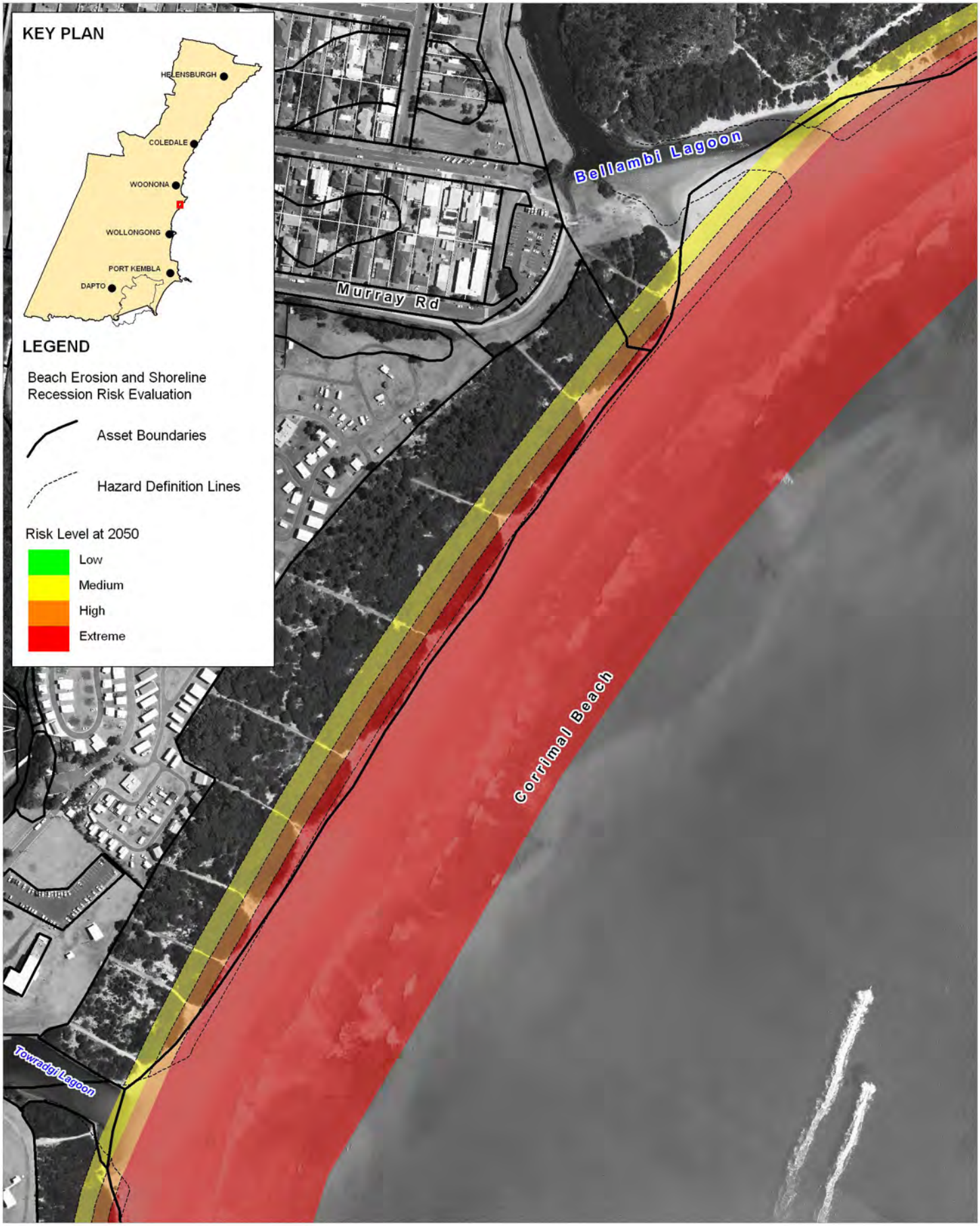
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_144_110415 Drawing B-14.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Corrimal Beach

Drawing: **B-15**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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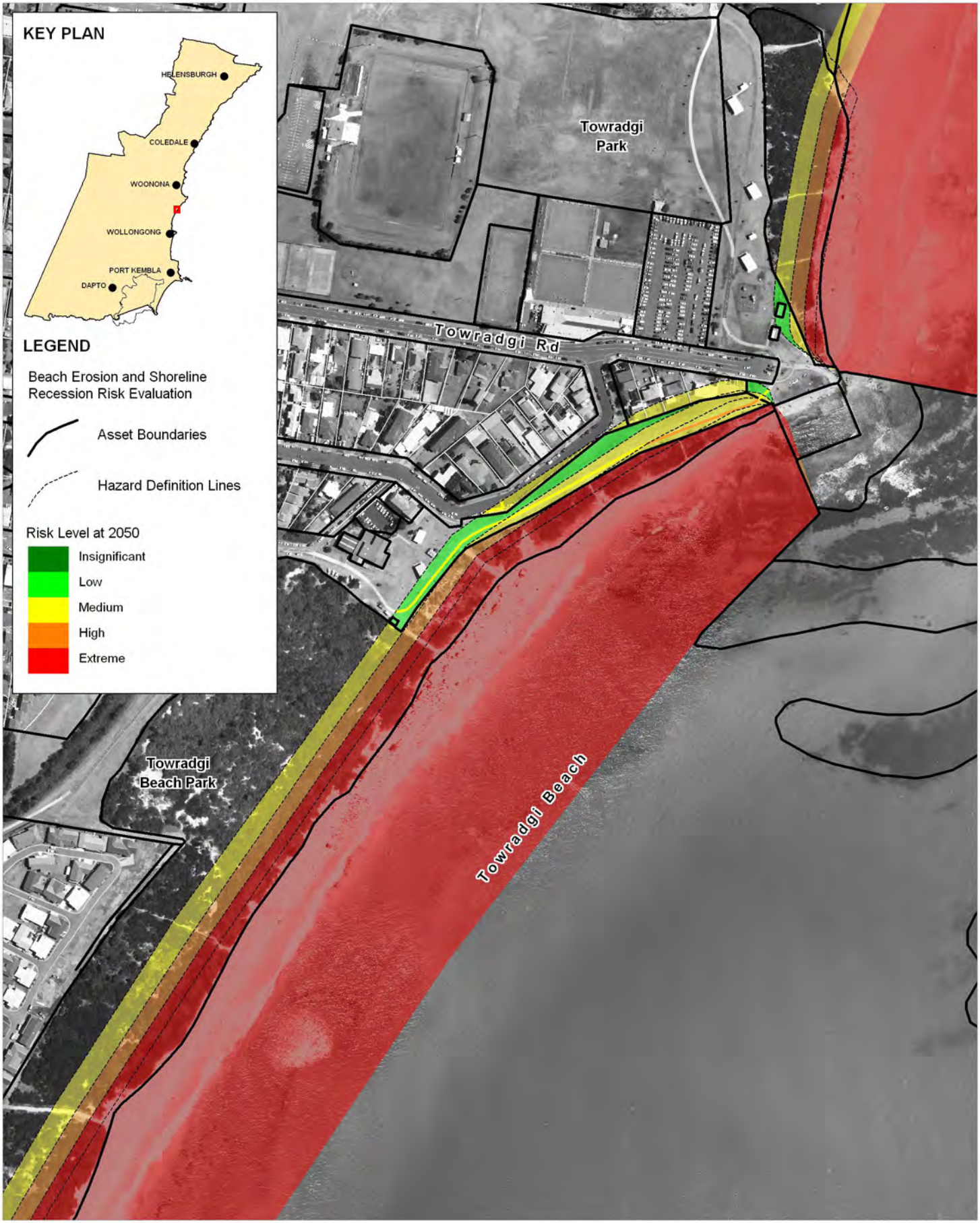
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_145_110415 Drawing B-15.WOR



Title:

Coastal Hazard Risk Evaluation
2050 Planning Horizon - Towradgi Beach

Drawing: **B-16**

Rev: **A**

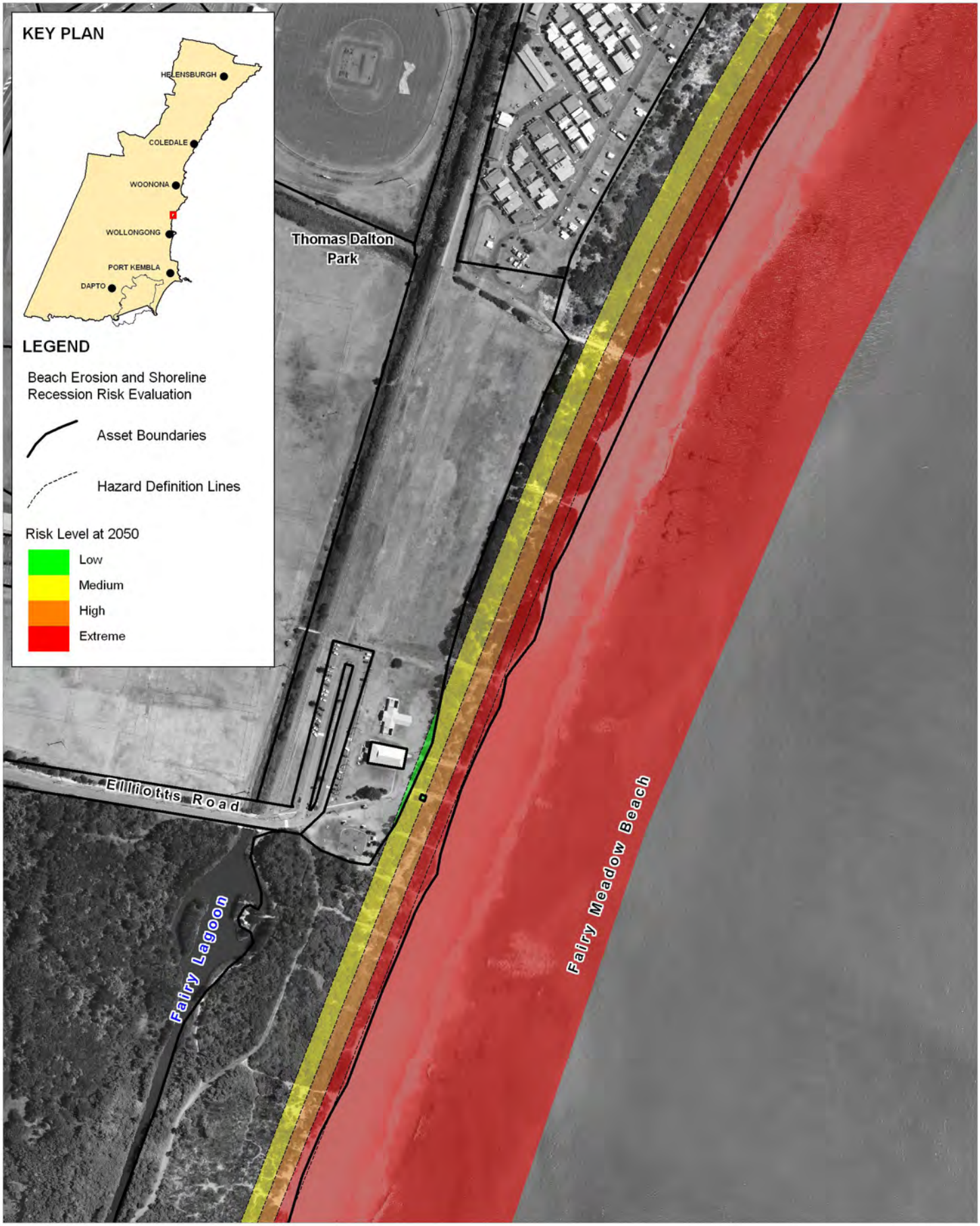
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_146_110415 Drawing B-16.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Fairy Meadow Beach (north)

Drawing: B-17

Rev: A

N

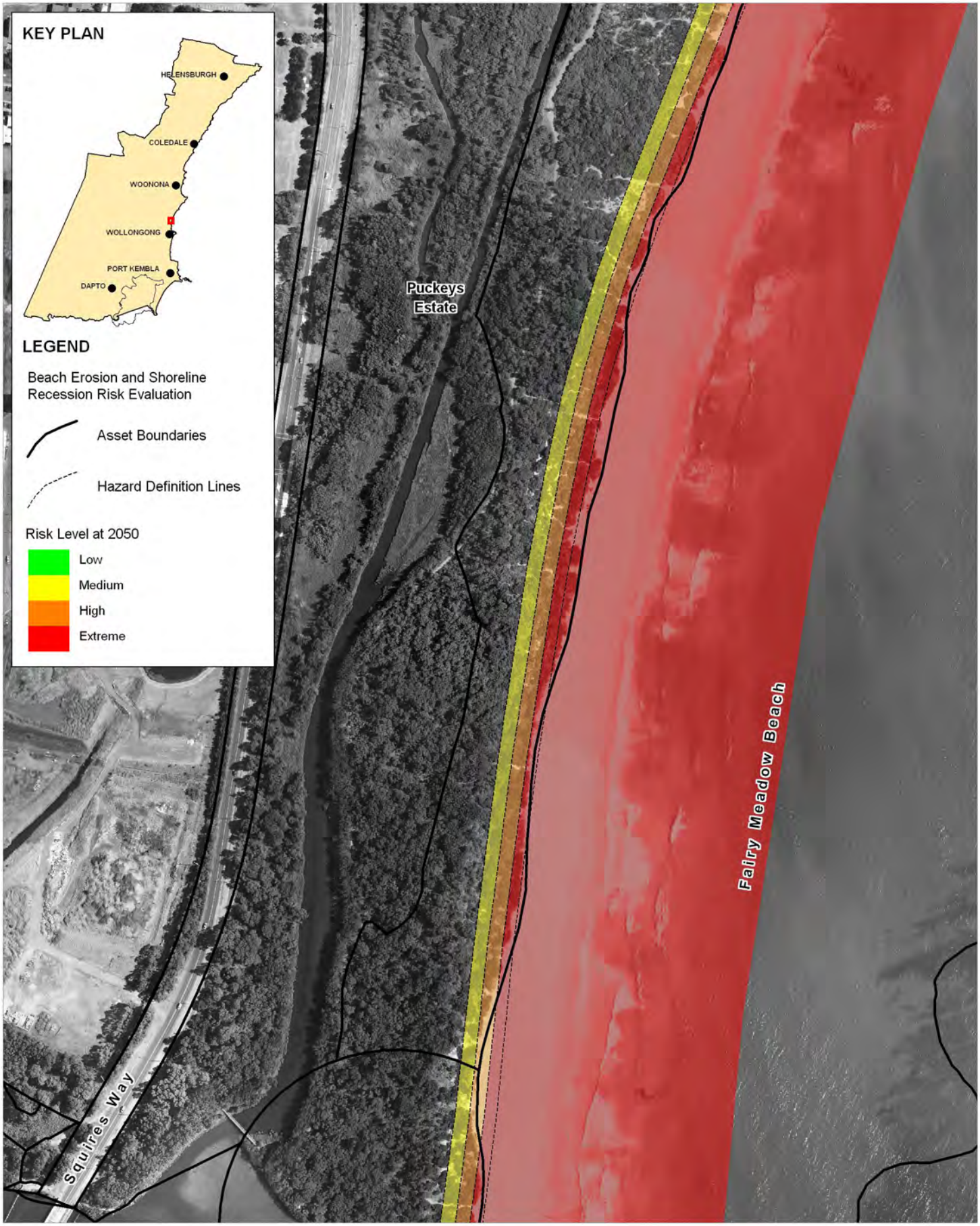
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_147_110415 Drawing B-17.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Fairy Meadow Beach (south)

Drawing: B-18

Rev: A

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N

0 75 150m

Approx. Scale

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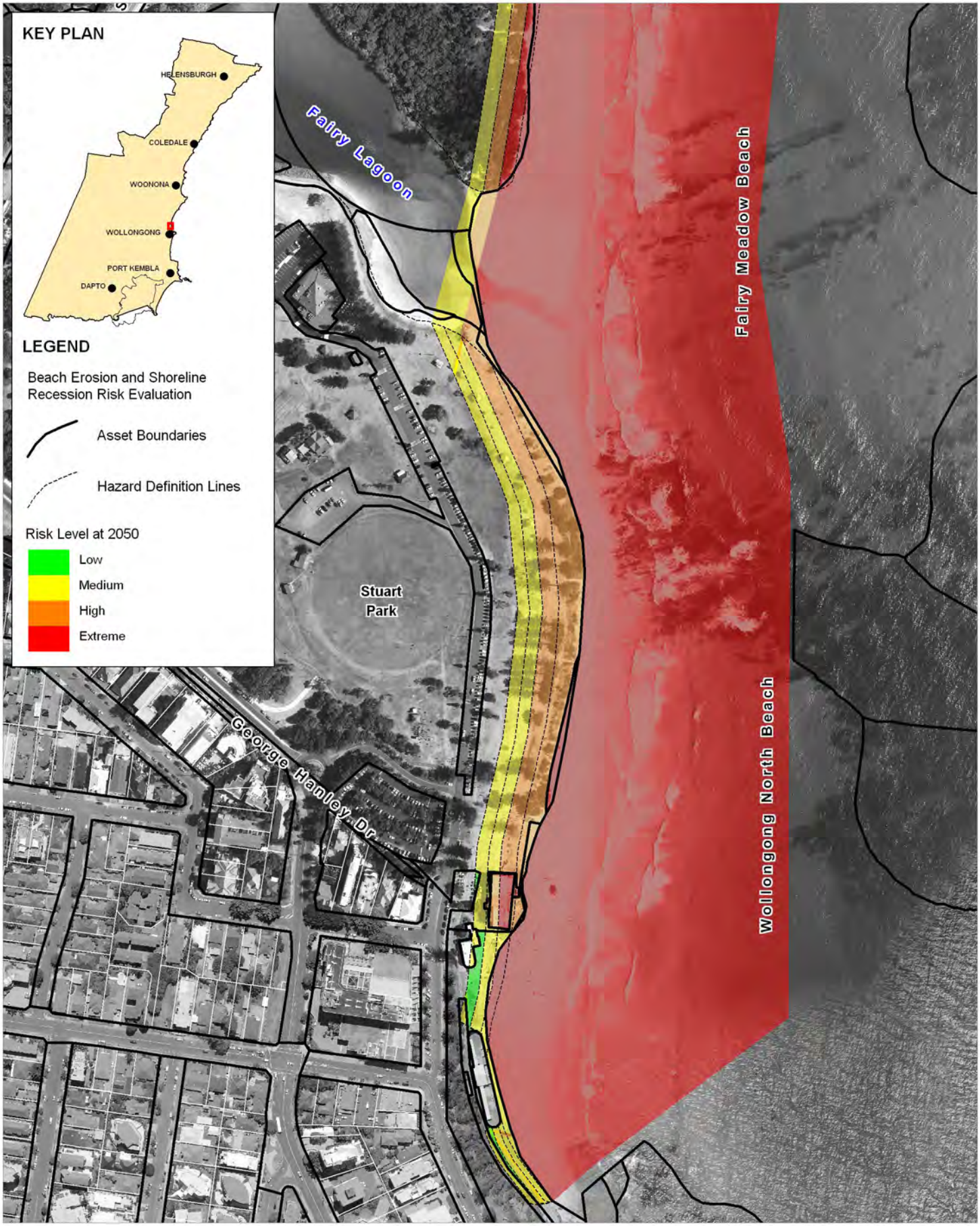
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_148_110415 Drawing B-18.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Wollongong North Beach

Drawing: B-19

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
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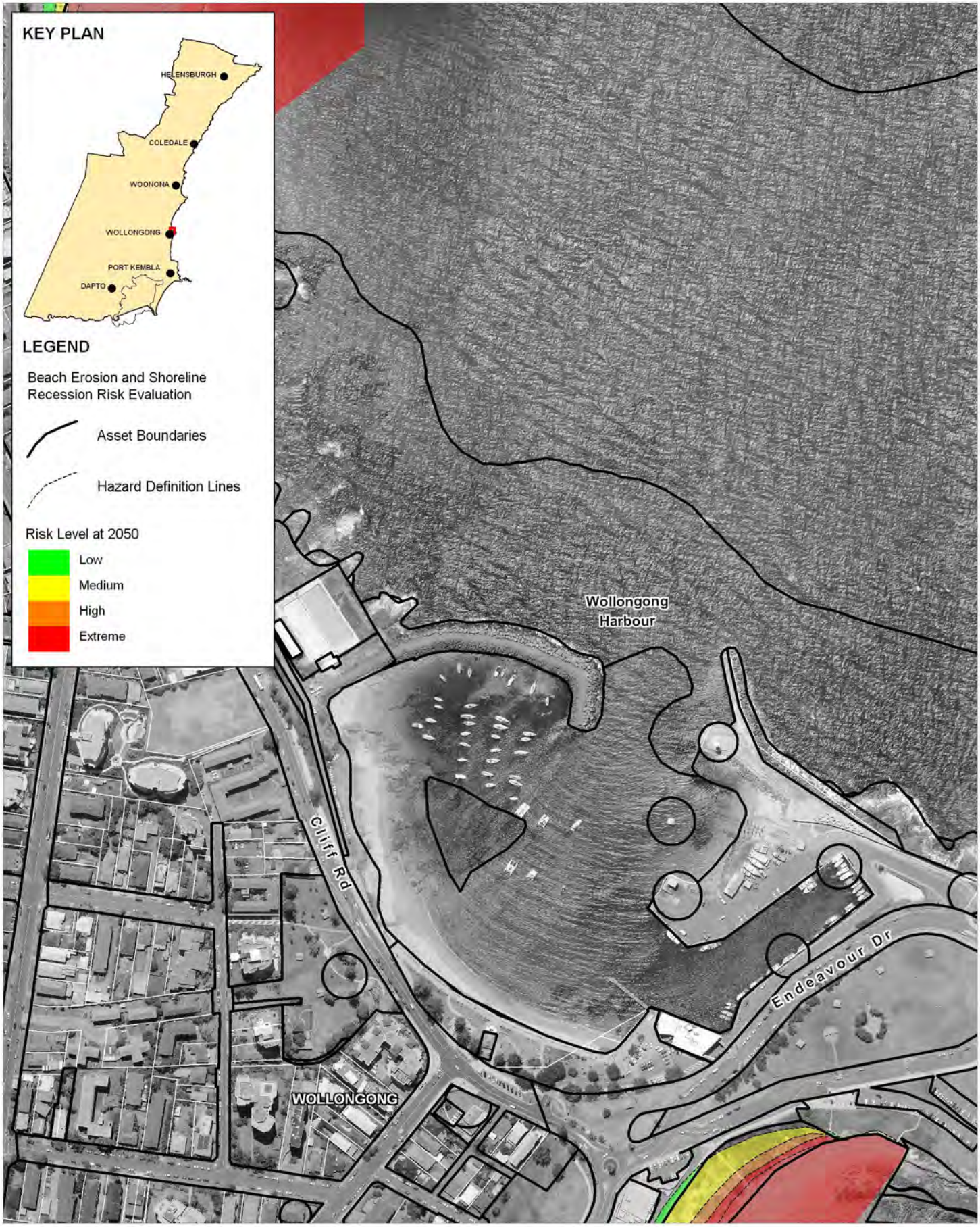
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_149_110415 Drawing B-19.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Wollongong Harbour

Drawing: **B-20**

Rev: **A**

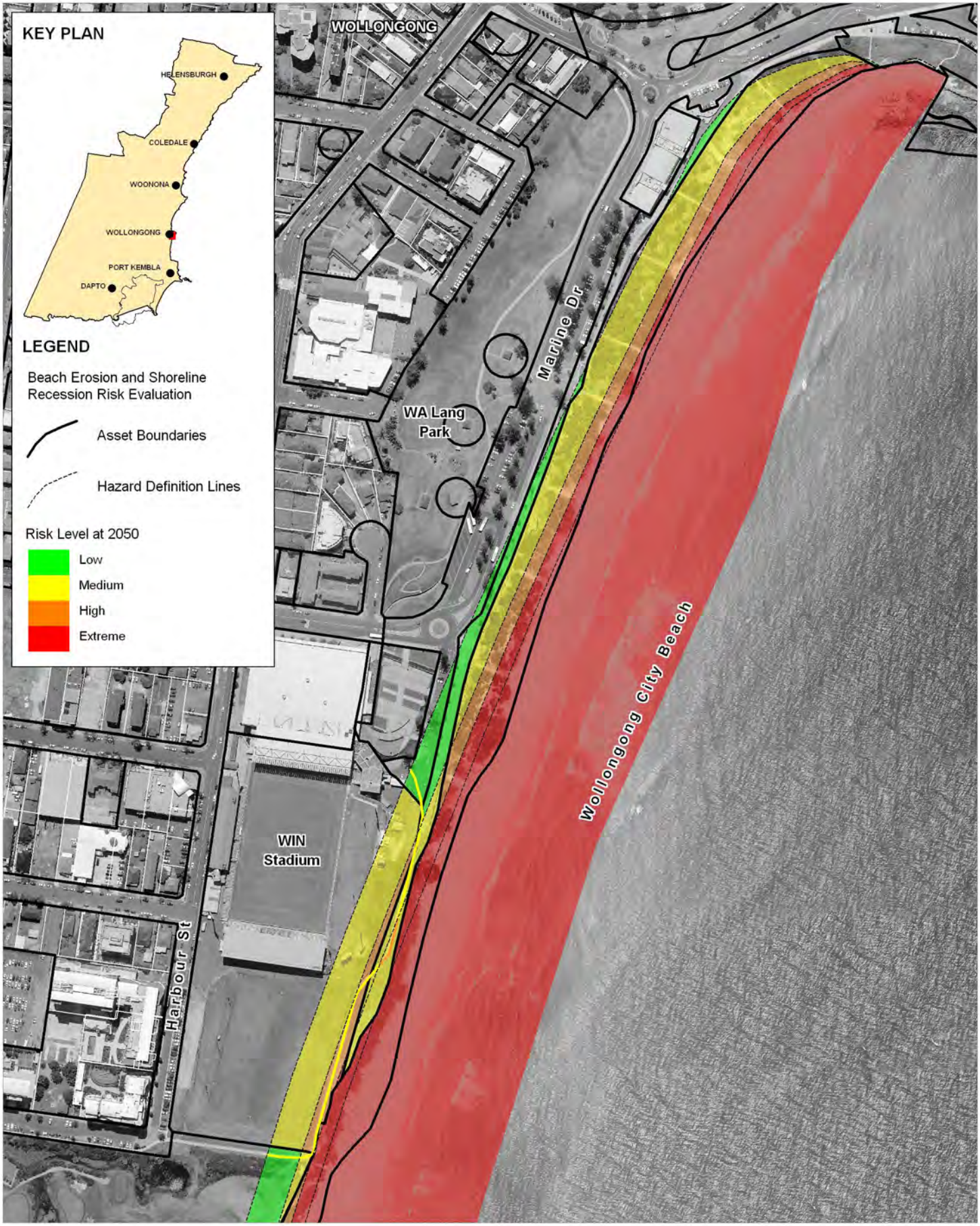
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_150_110415 Drawing B-20.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Wollongong City Beach

Drawing: B-21

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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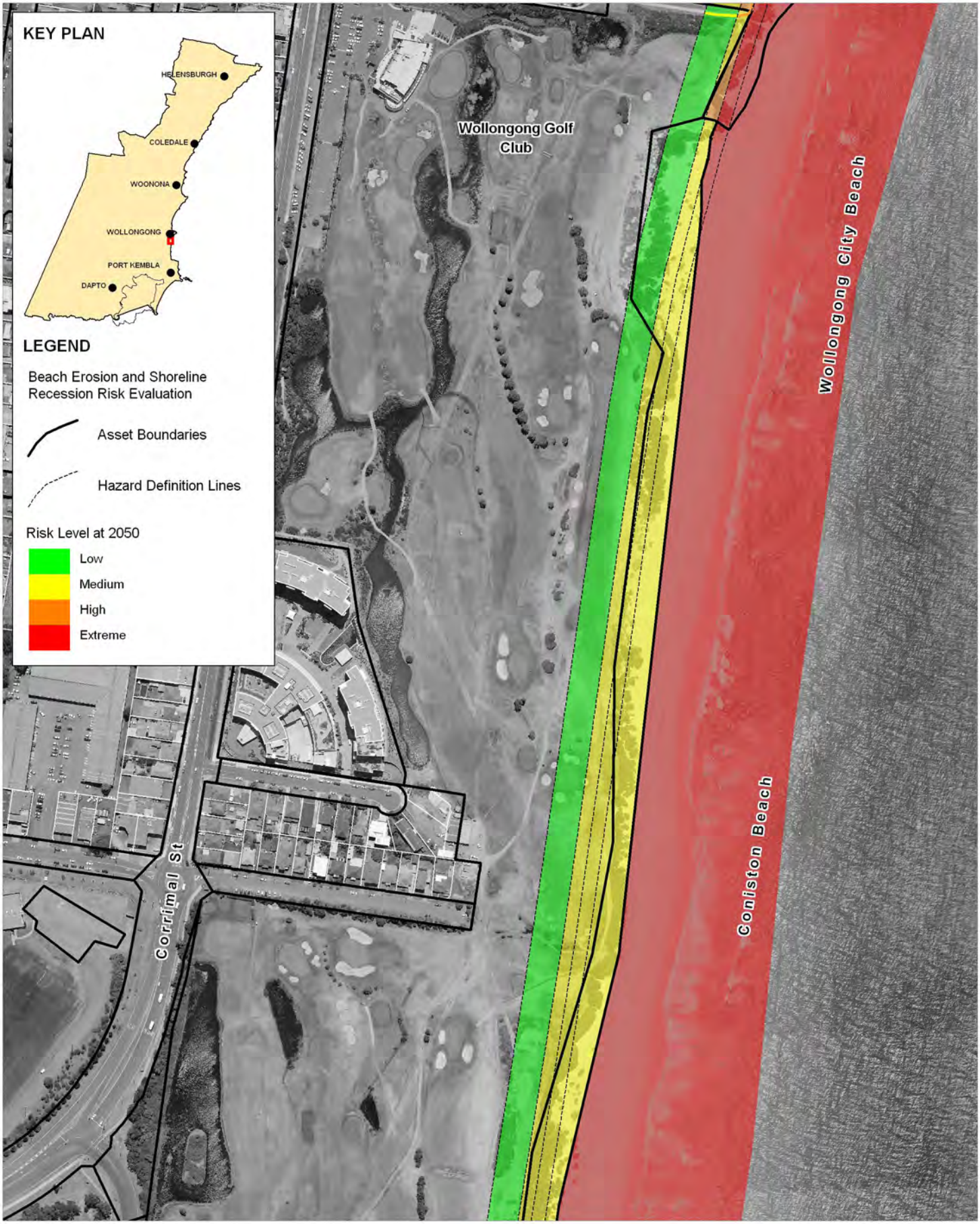
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_151_110418 Drawing B-21.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Coniston Beach (north)

Drawing: B-22

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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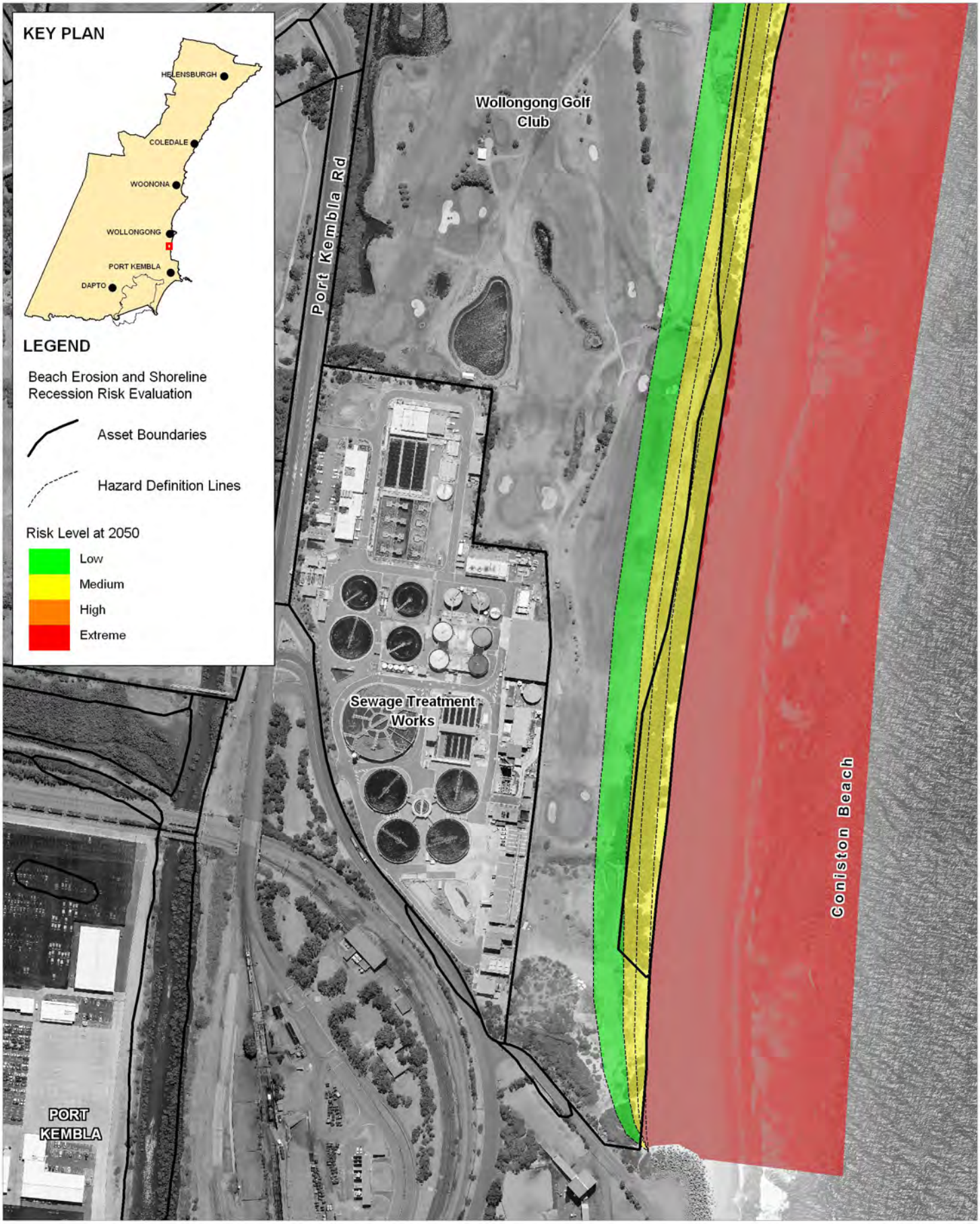
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_152_110418 Drawing B-22.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Coniston Beach (south)

Drawing: B-23

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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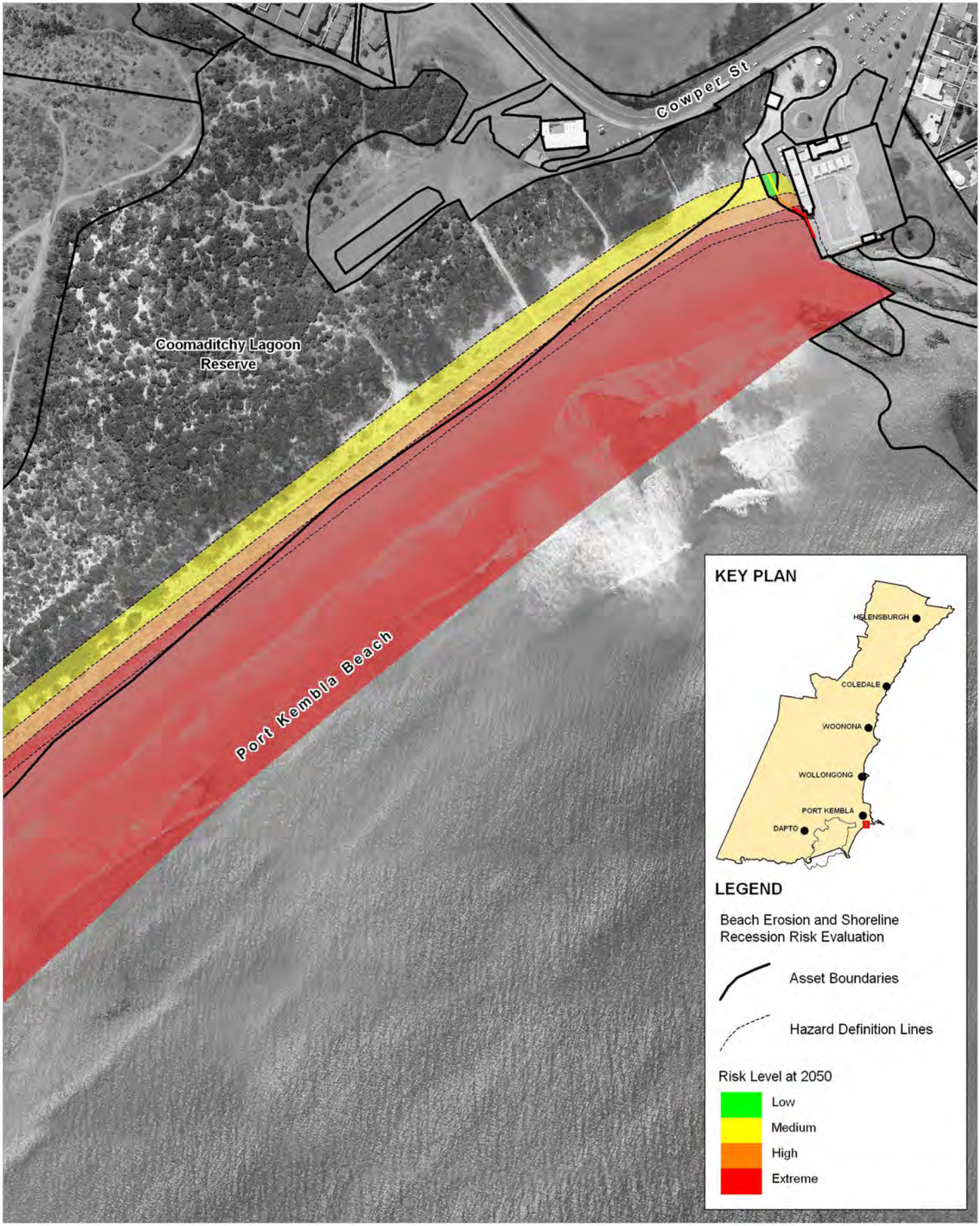
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_153_110418 Drawing B-23.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Port Kembla Beach

Drawing: **B-24**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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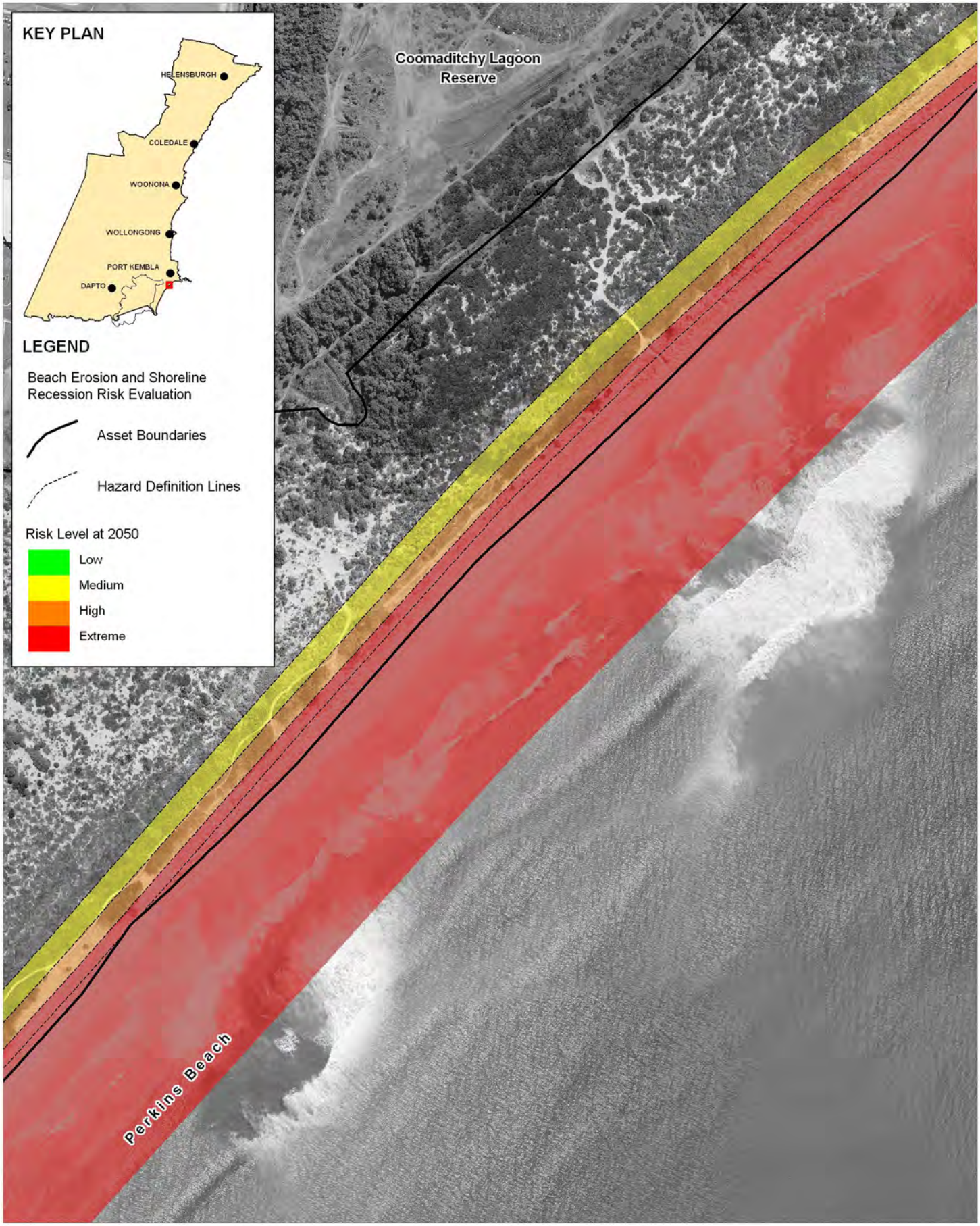
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_154_110418 Drawing B-24.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Perkins Beach (1)

Drawing: **B-25**

Rev: **A**

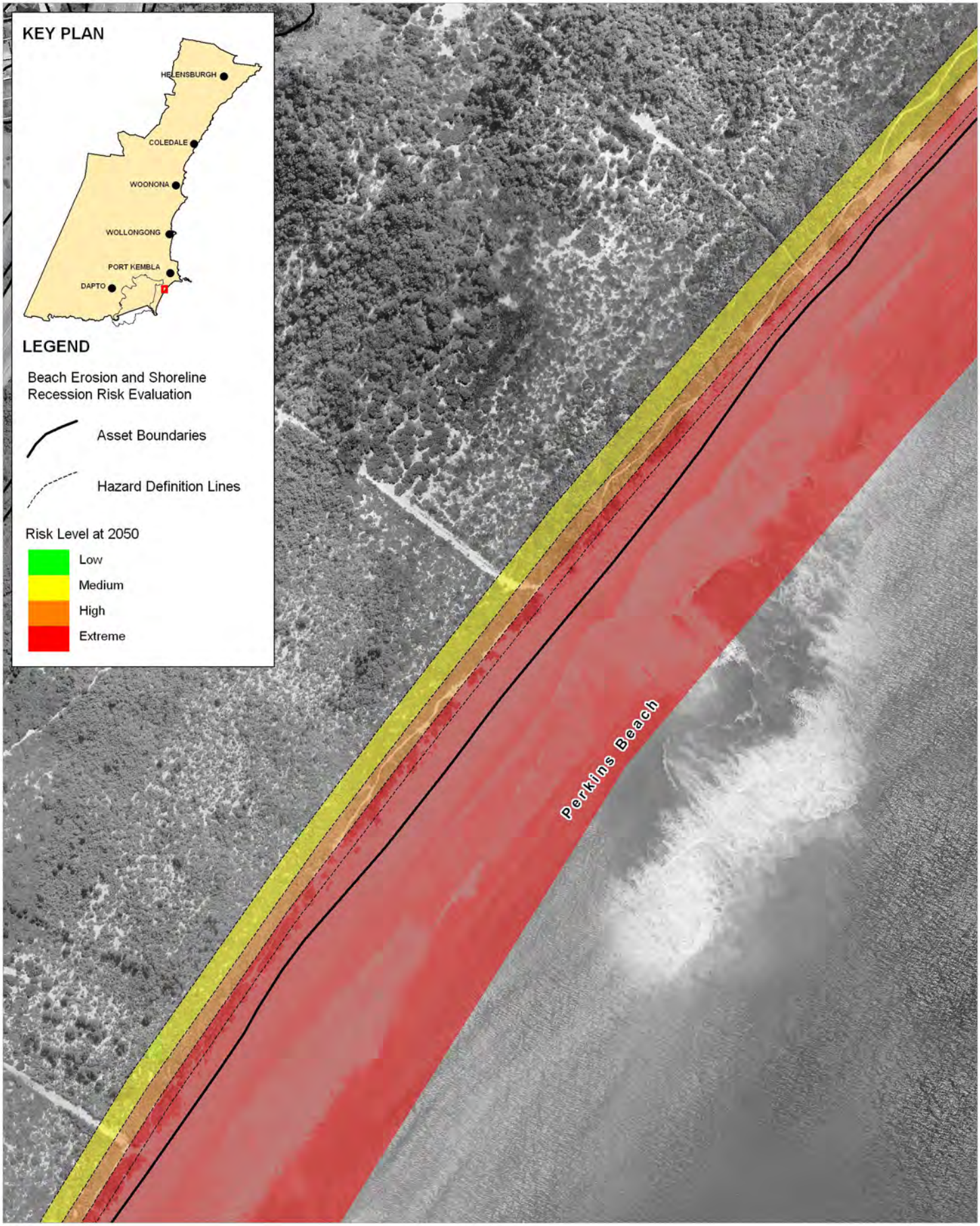
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_155_110418 Drawing B-25.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Perkins Beach (2)

Drawing: **B-26**

Rev: **A**

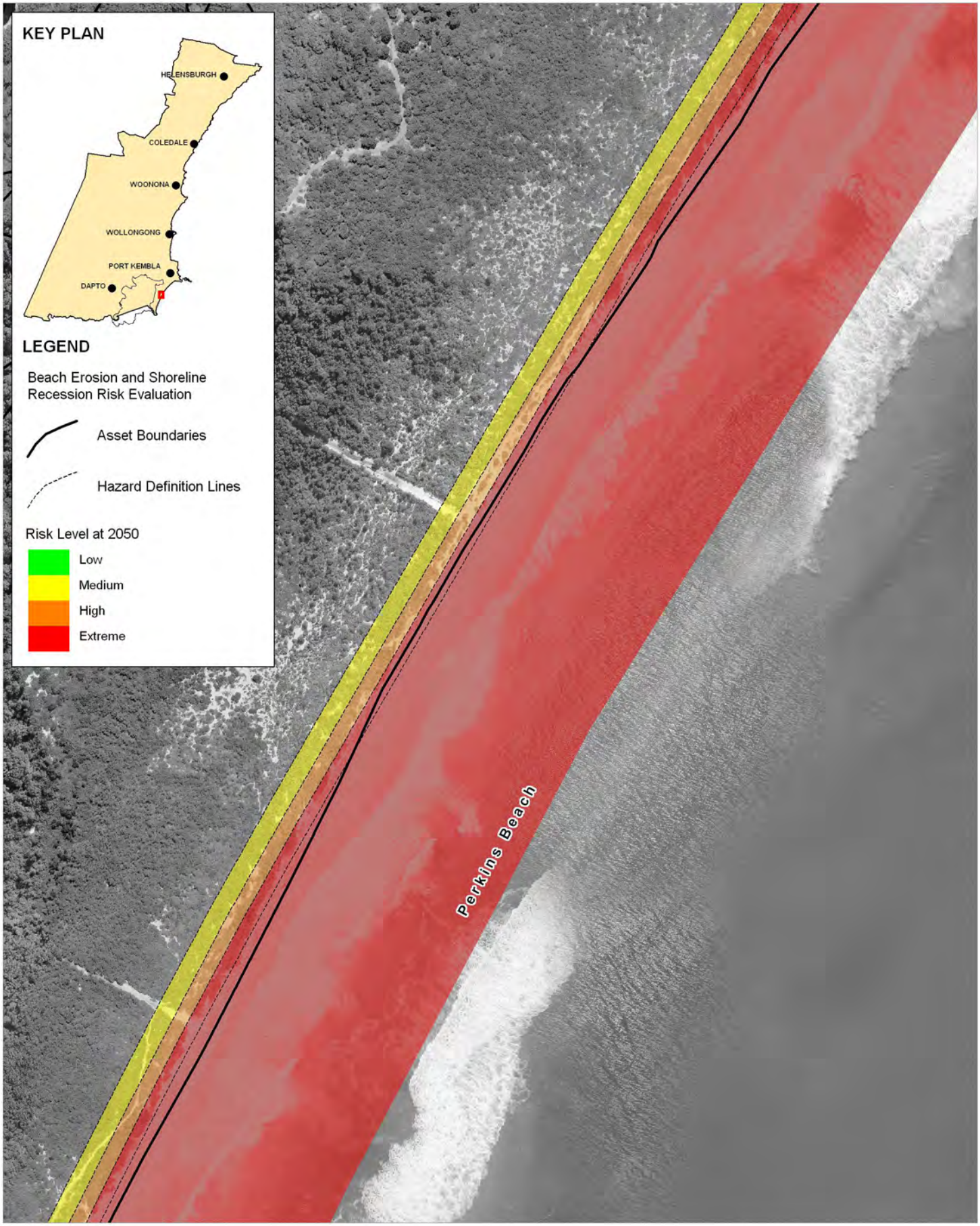
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_156_110418 Drawing B-26.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Perkins Beach (3)

Drawing: **B-27**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM
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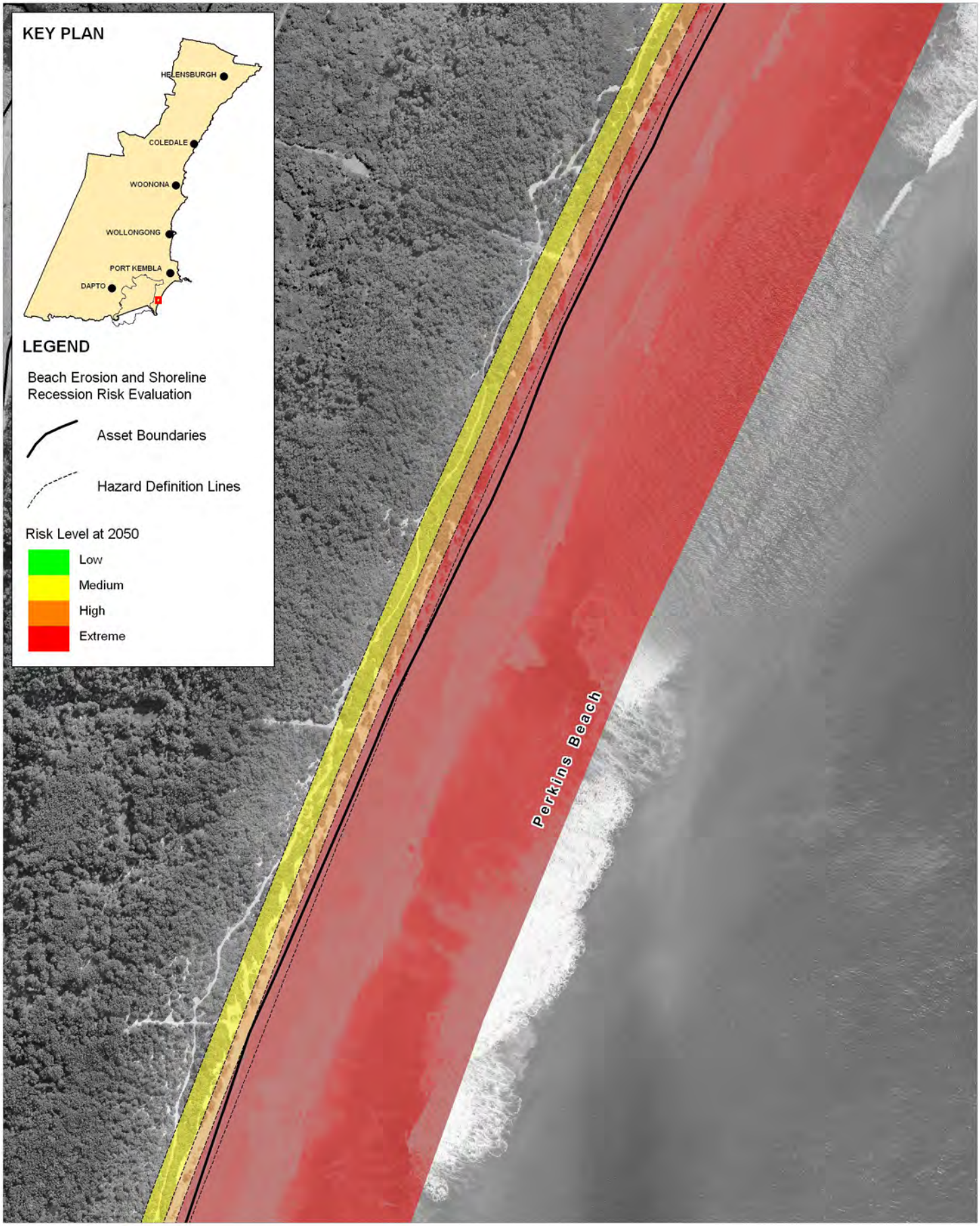
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_157_110418 Drawing B-27.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Perkins Beach (4)

Drawing: **B-28**

Rev: **A**

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N

0 75 150m

Approx. Scale

BMT WBM
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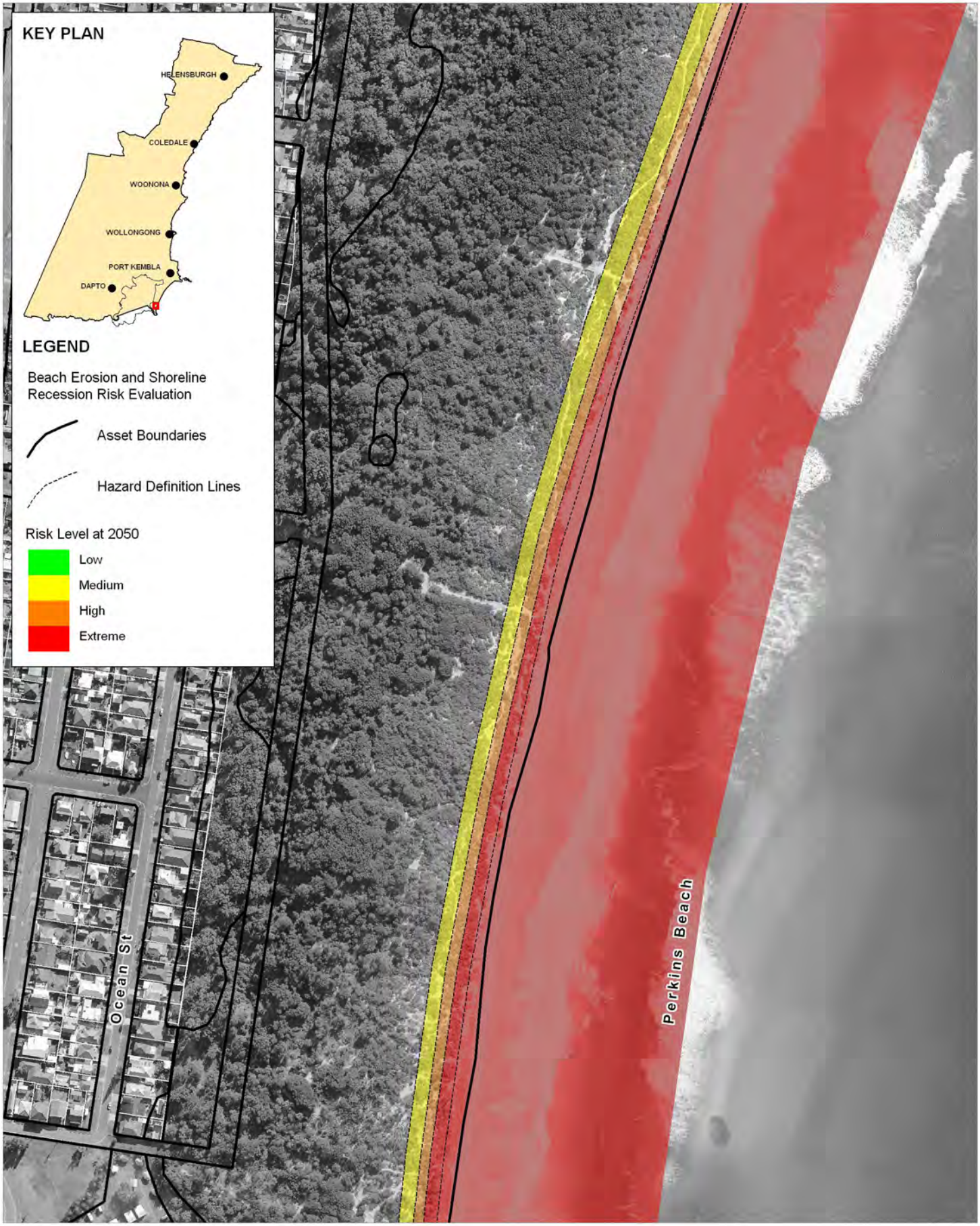
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_158_110418 Drawing B-28.WOR



Title:

Erosion and Recession Risk Evaluation
2050 Planning Horizon - Perkins Beach (5)

Drawing: **B-29**

Rev: **A**

N

0 75 150m

Approx. Scale

BMT WBM

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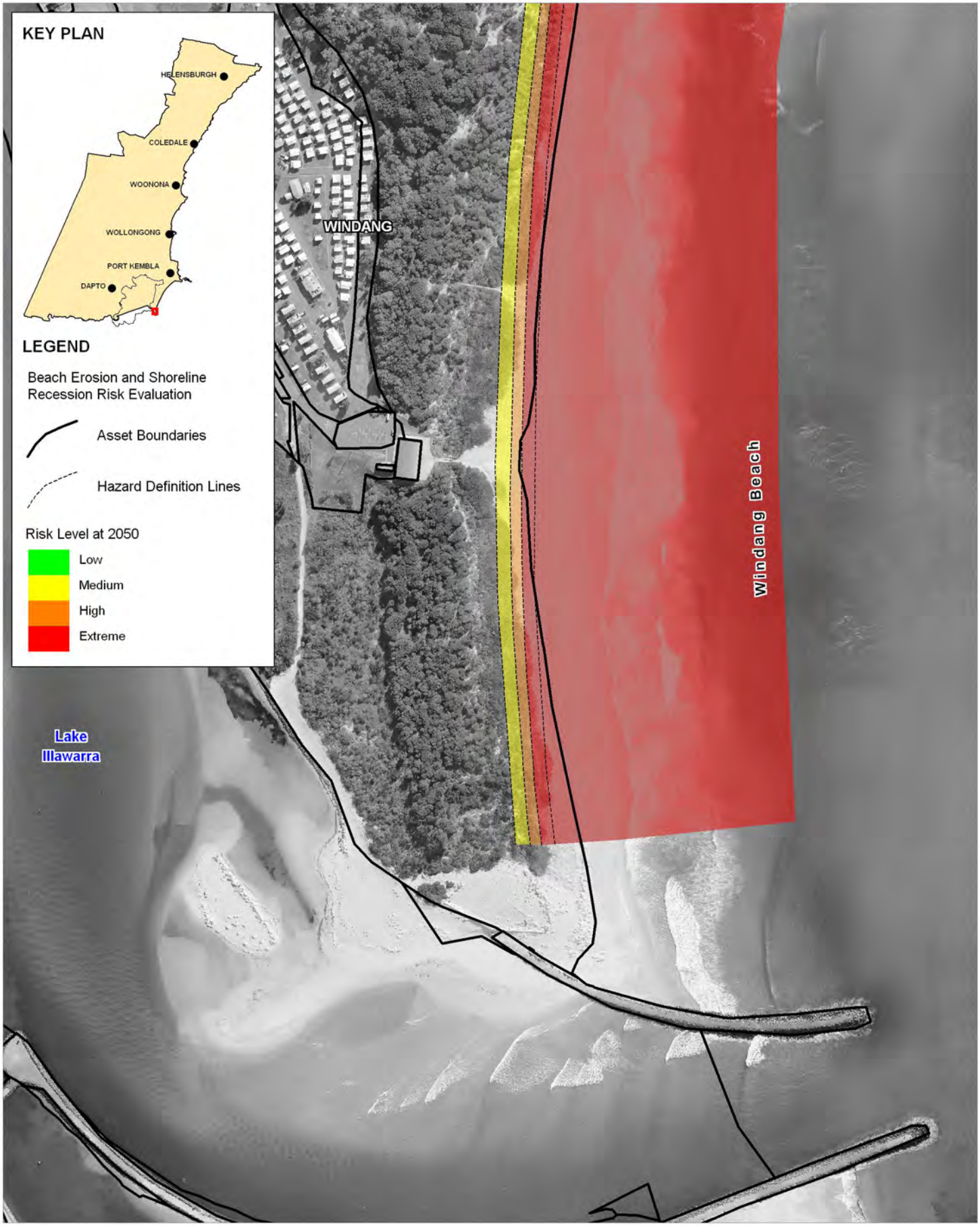
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_159_110418 Drawing B-29.WOR



Title:

Erosion and Recession Risk Evaluation 2050 Planning Horizon - Windang Beach

Drawing: B-30

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM

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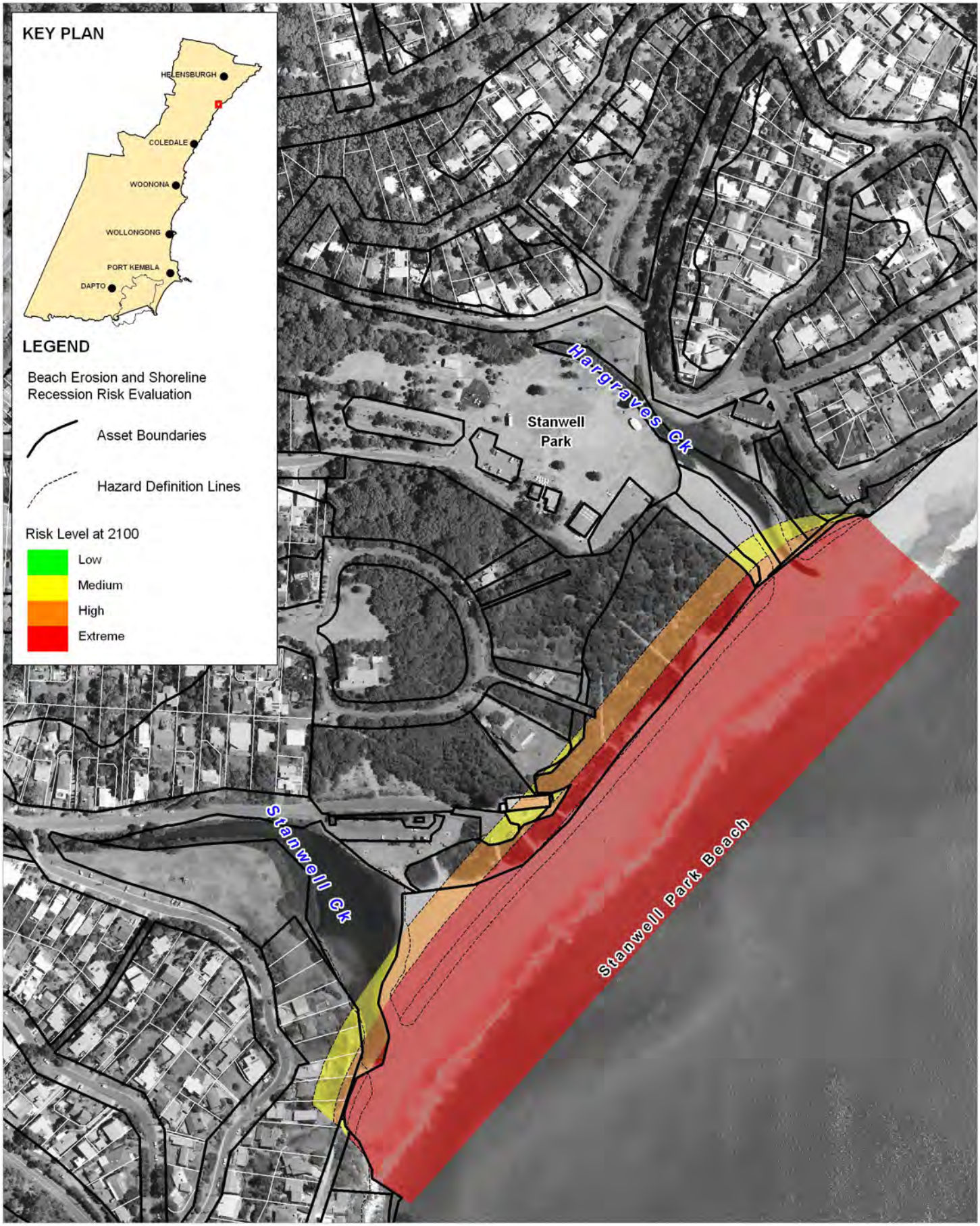
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_160_110418 Drawing B-30.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Stanwell Park

Drawing: C-1

Rev: A

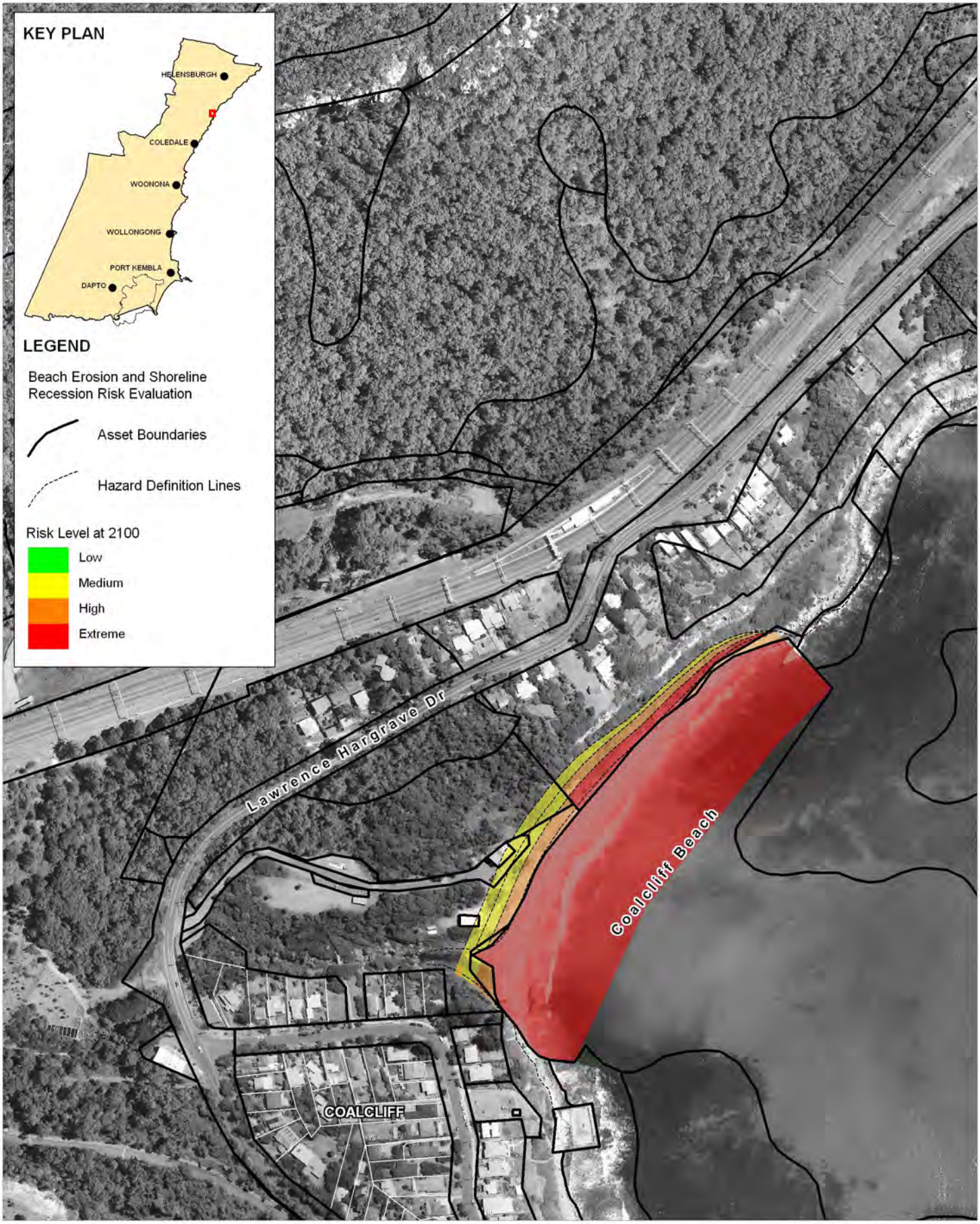
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_161_110415 Drawing C-1.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Coalcliff

Drawing: C-2

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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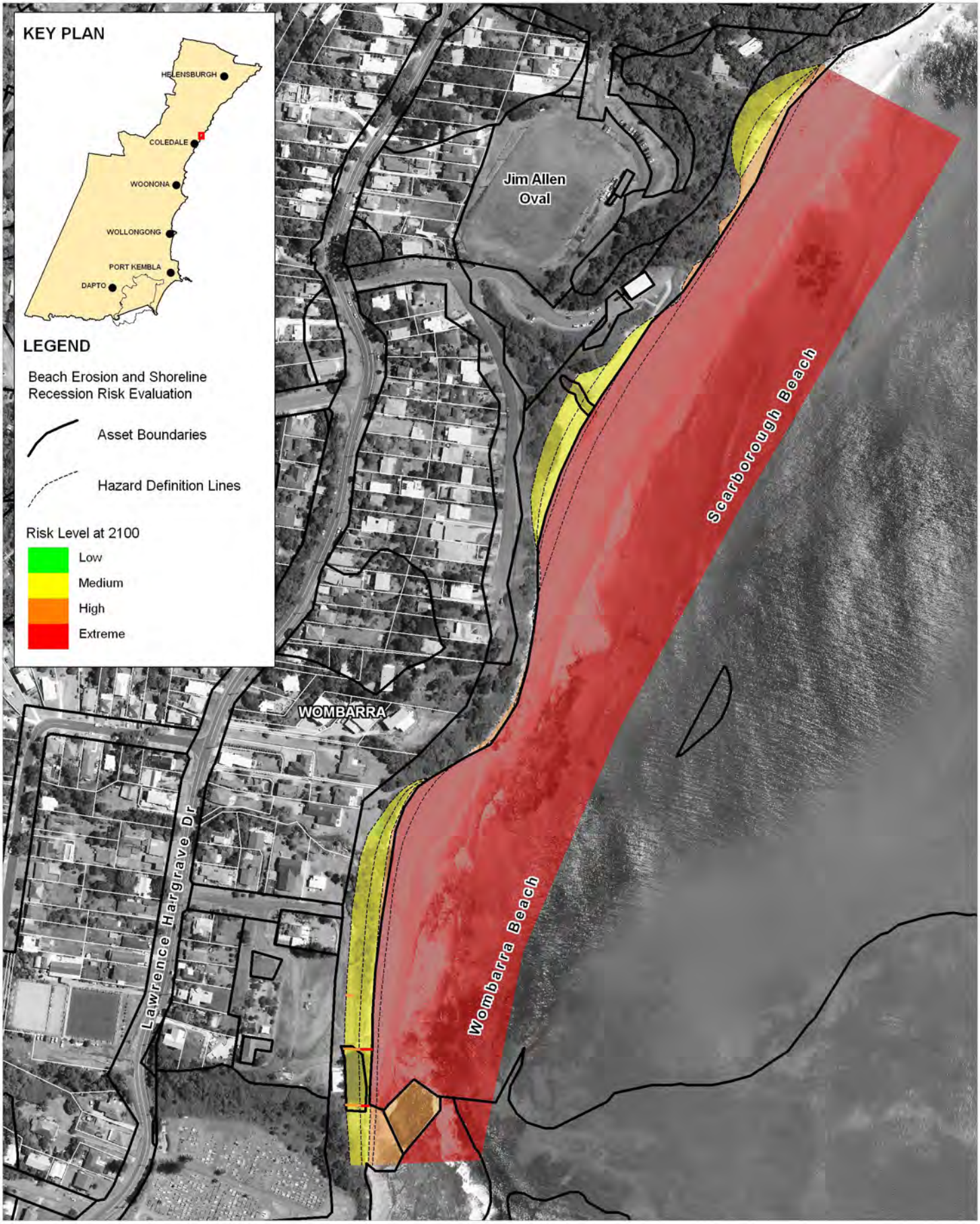
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_162_110415 Drawing C-2.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Scarborough/Wombarra

Drawing: C-3

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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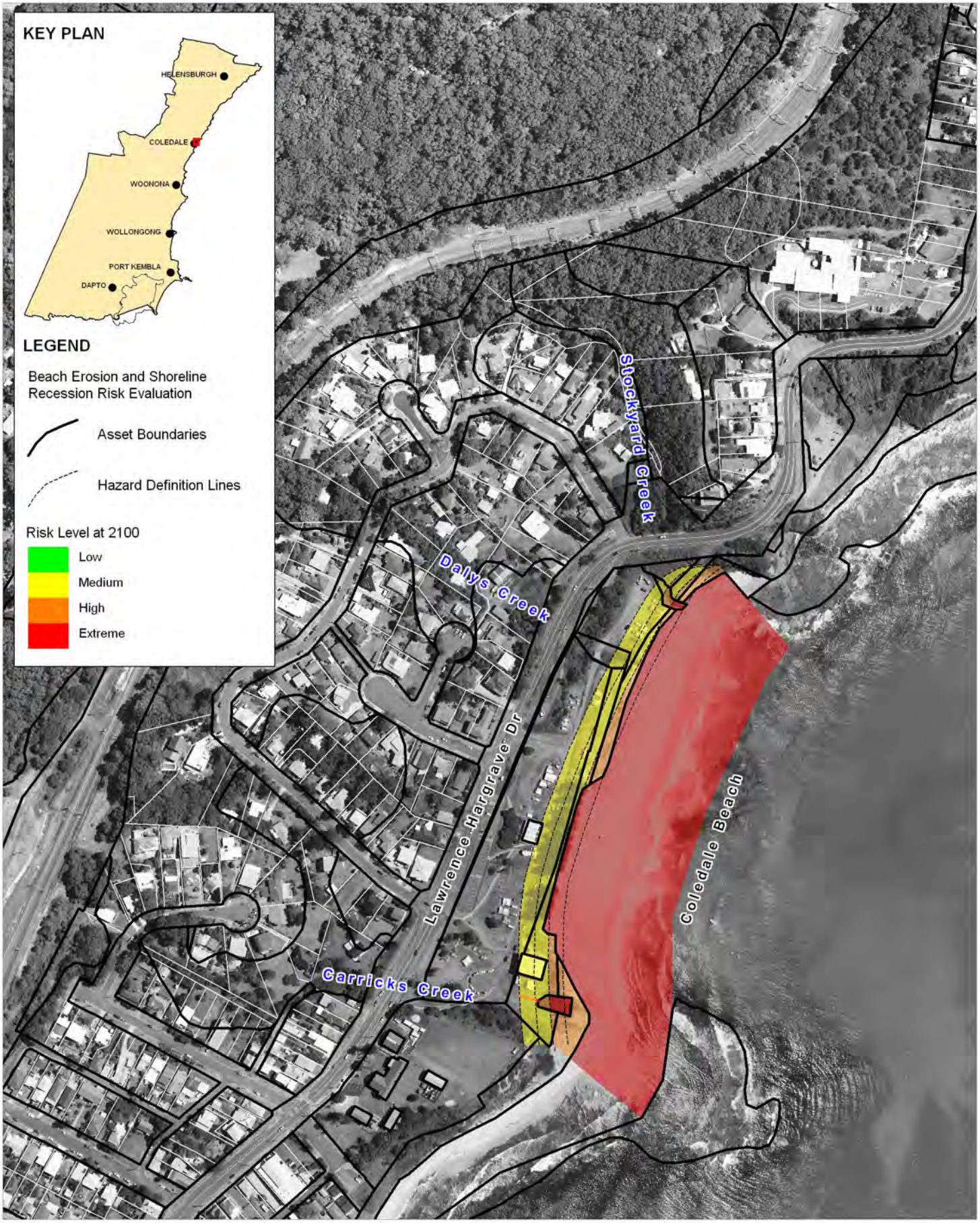
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_163_110415 Drawing C-3.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Coledale

Drawing: C-4

Rev: A

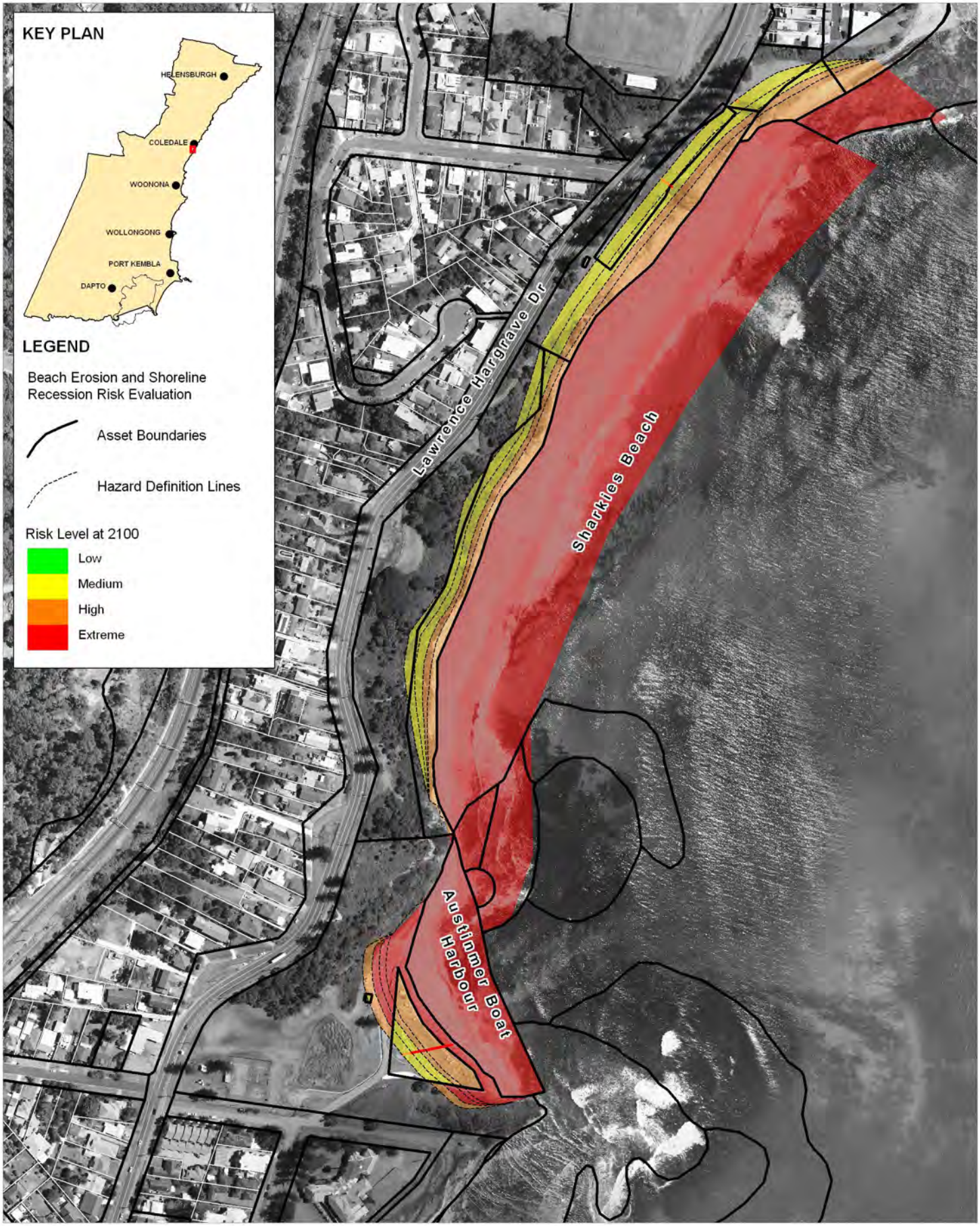
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_164_110415 Drawing C-4.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Sharkies Beach

Drawing: C-5

Rev: A

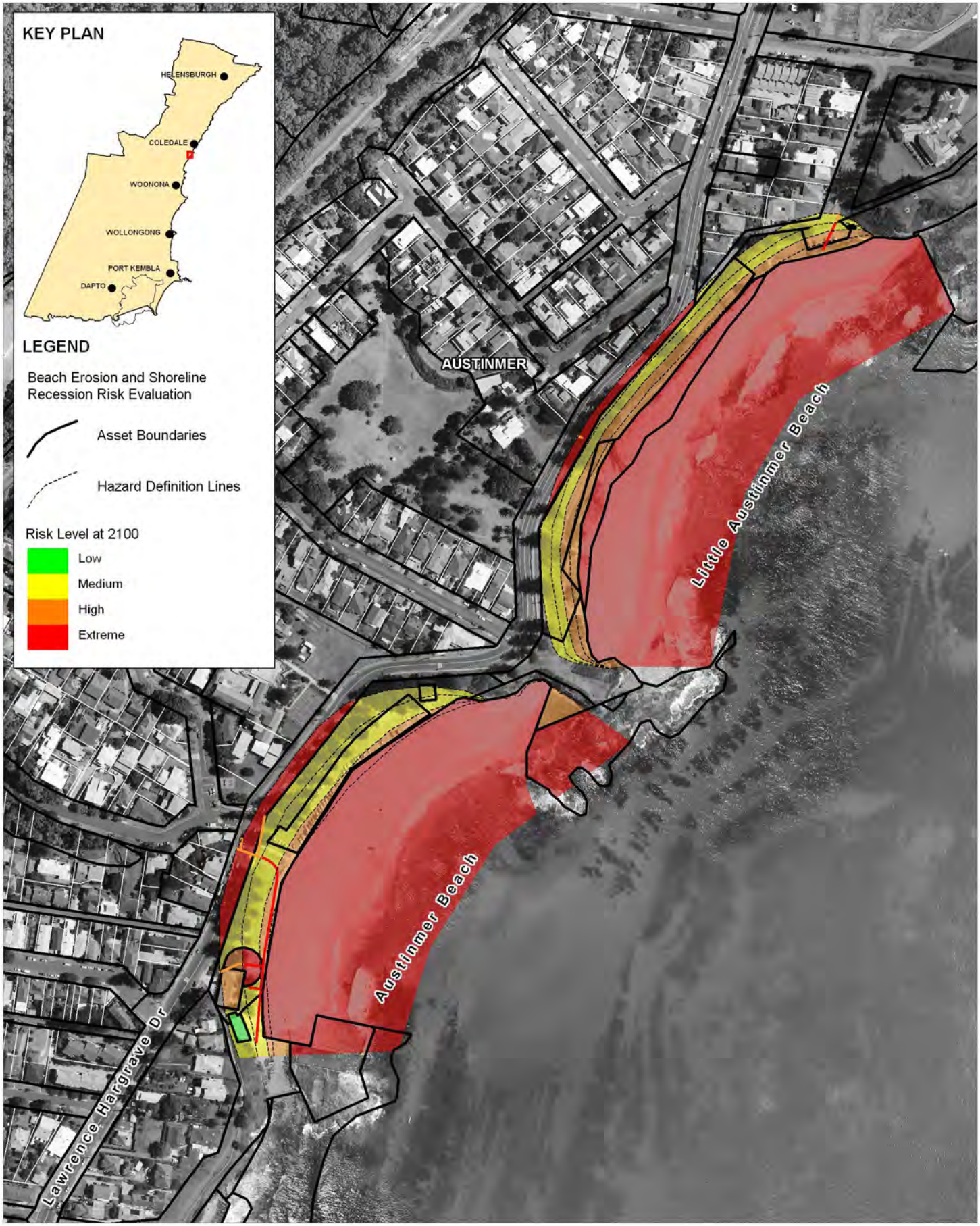
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_165_110415 Drawing C-5.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Austinmer

Drawing: C-6

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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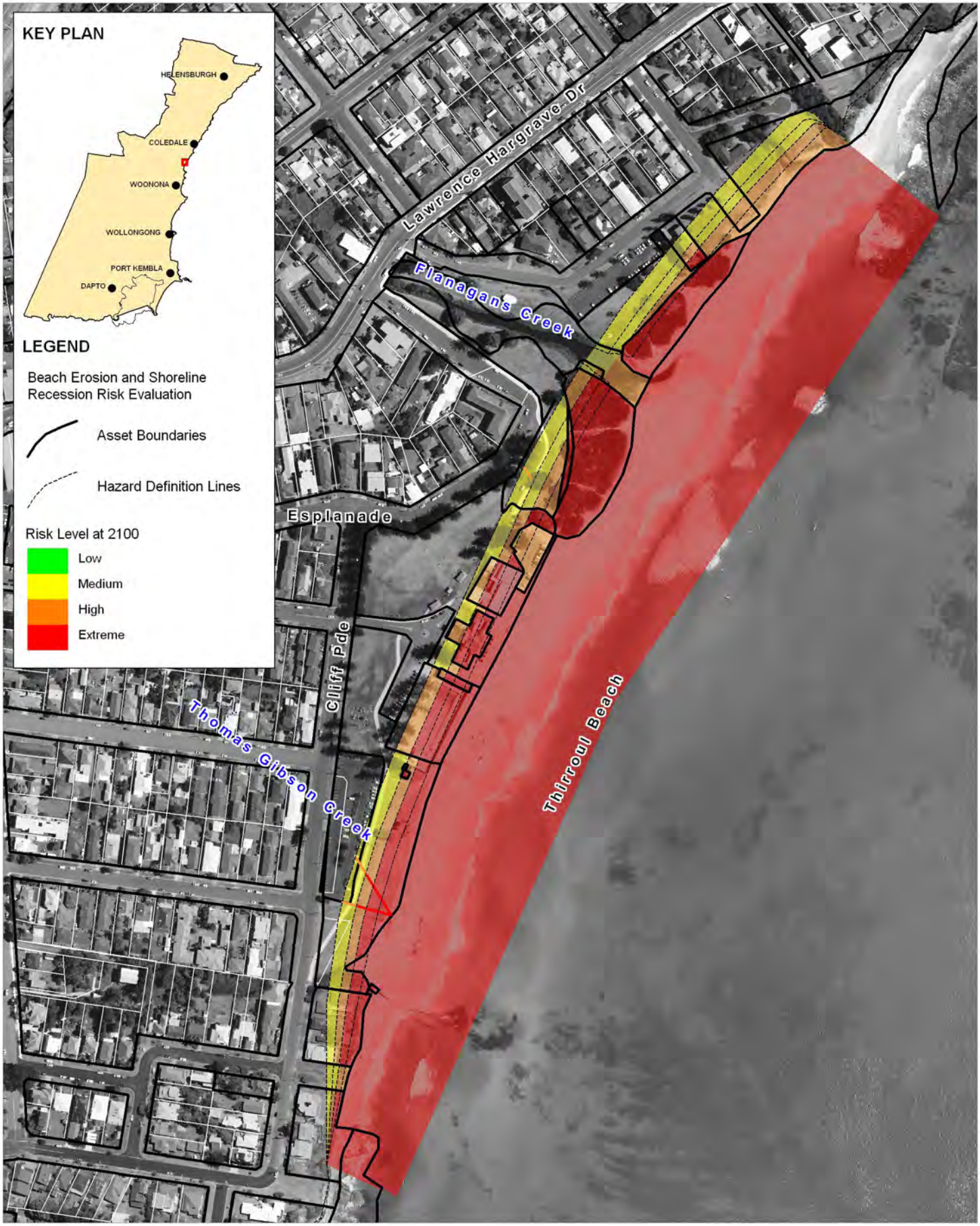
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_166_110415 Drawing C-6.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Thirroul

Drawing: C-7

Rev: A

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N

0 75 150m

Approx. Scale

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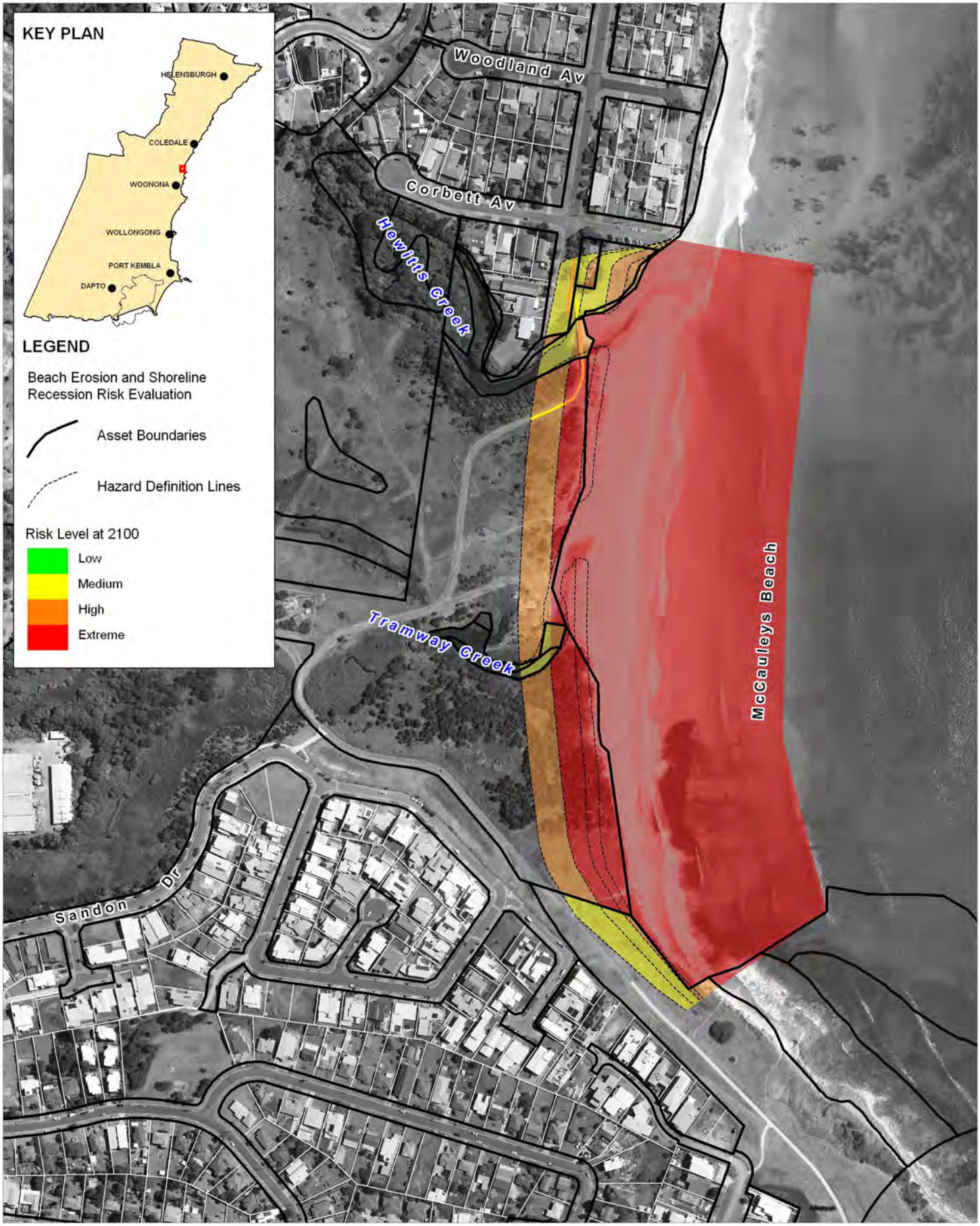
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_167_110414 Drawing C-7.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - McCauleys Beach

Drawing: C-8

Rev: A

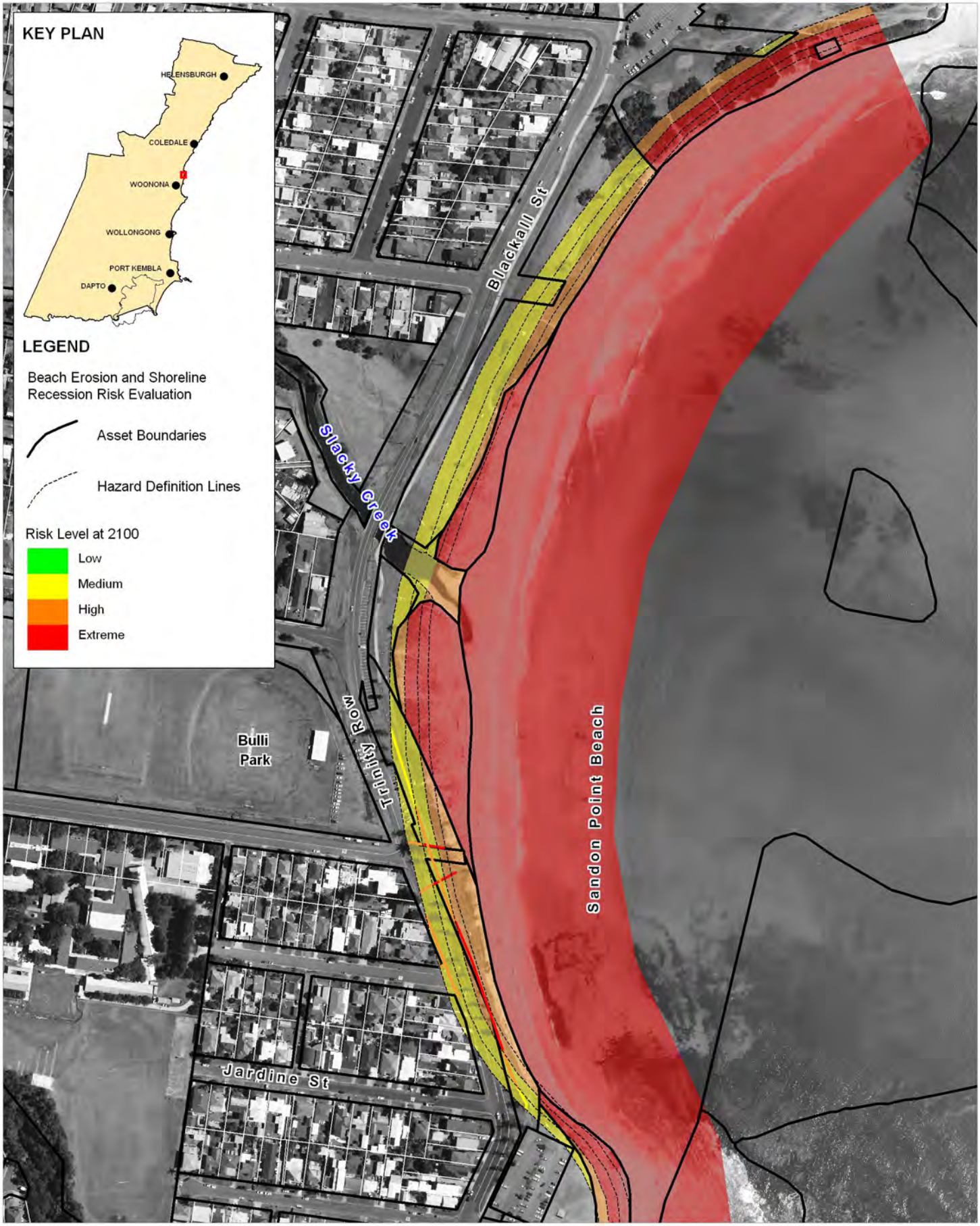
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_168_110415 Drawing C-8.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Sandon Point Beach

Drawing: C-9

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
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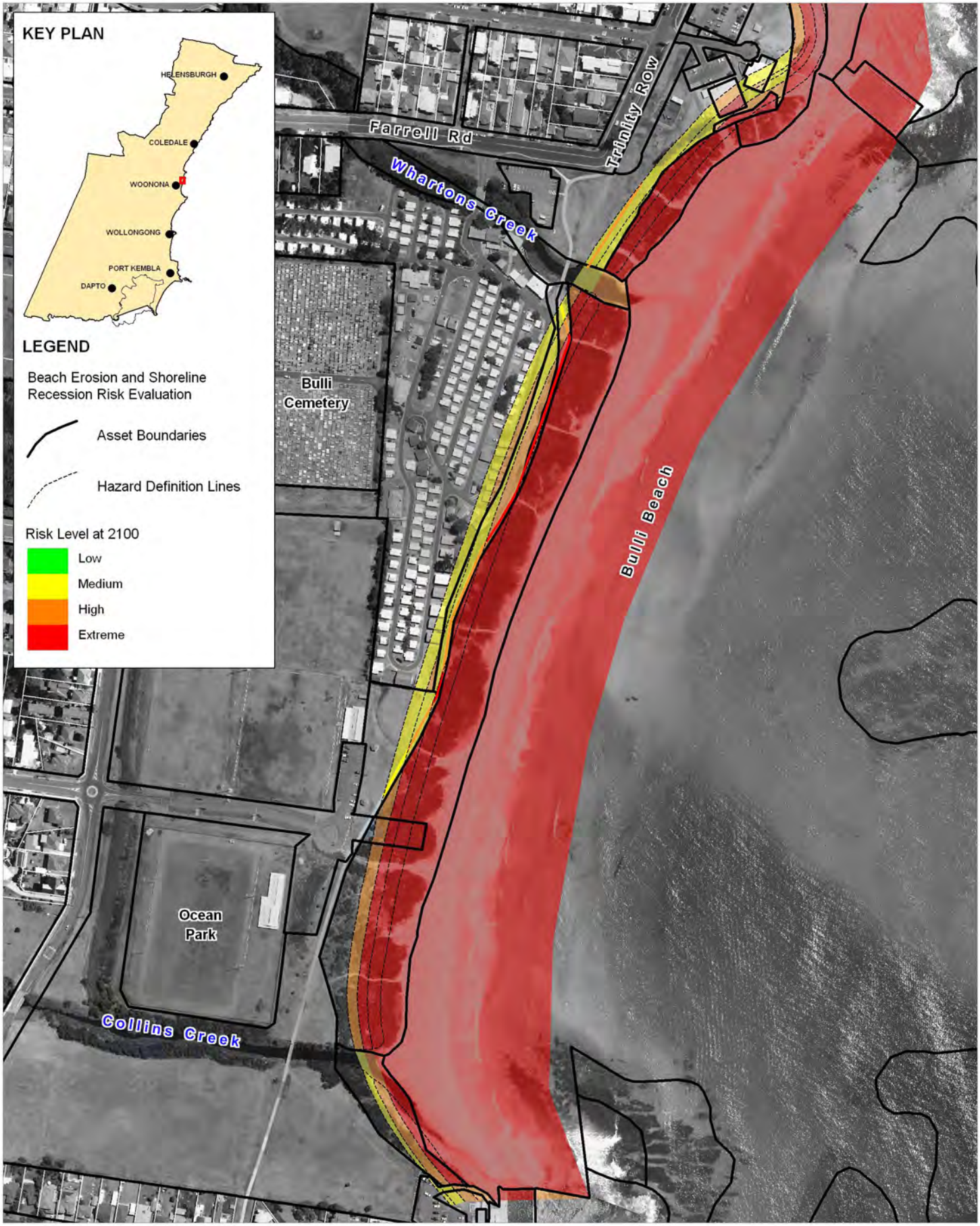
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_169_110415 Drawing C-9.WOR



Title:

Erosion and Recession Risk Evaluation 2100 Planning Horizon - Bulli Beach

Drawing: C-10

Rev: A

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N

0 75 150m

Approx. Scale

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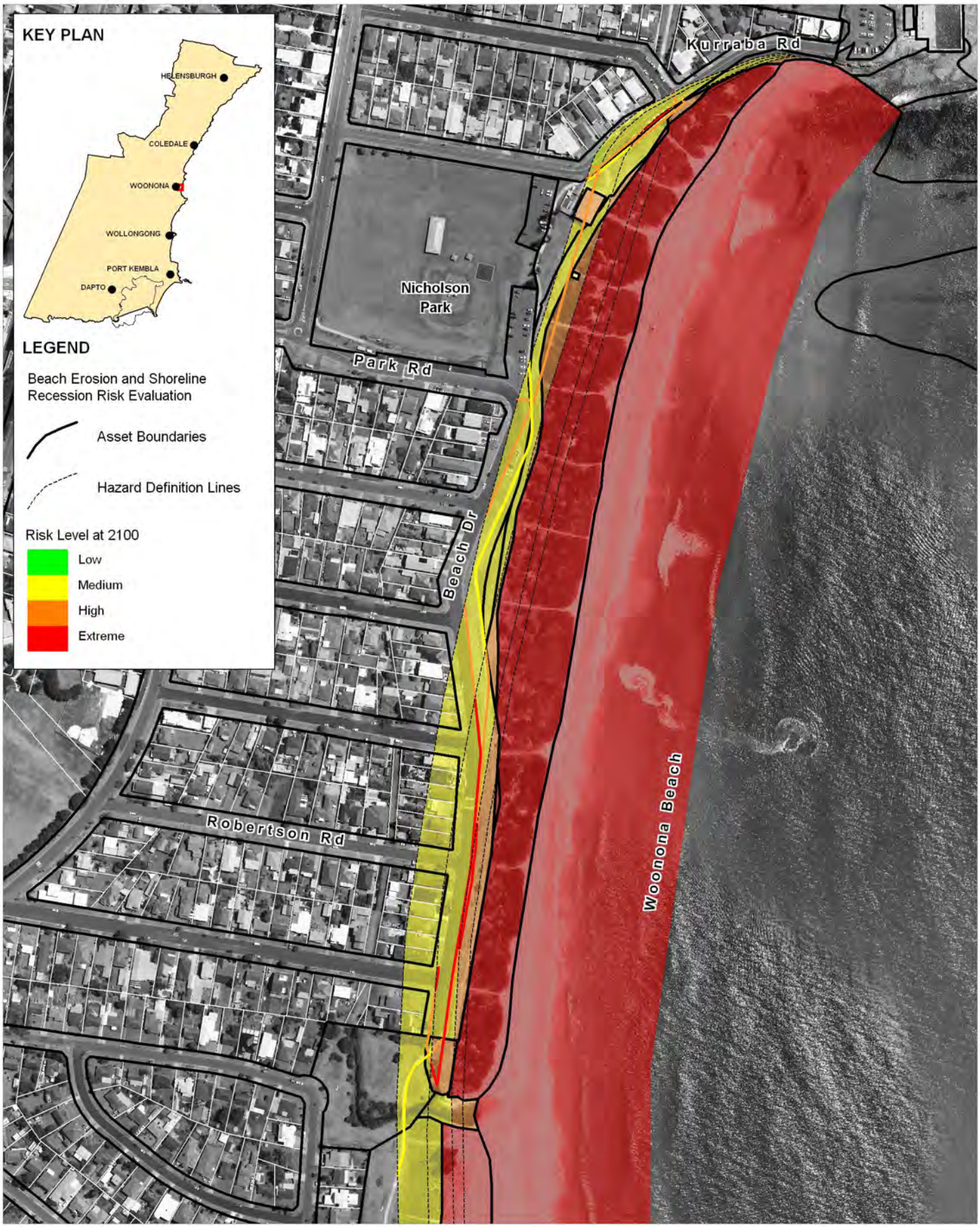
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_170_110415 Drawing C-10.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Woonona Beach

Drawing: C-11

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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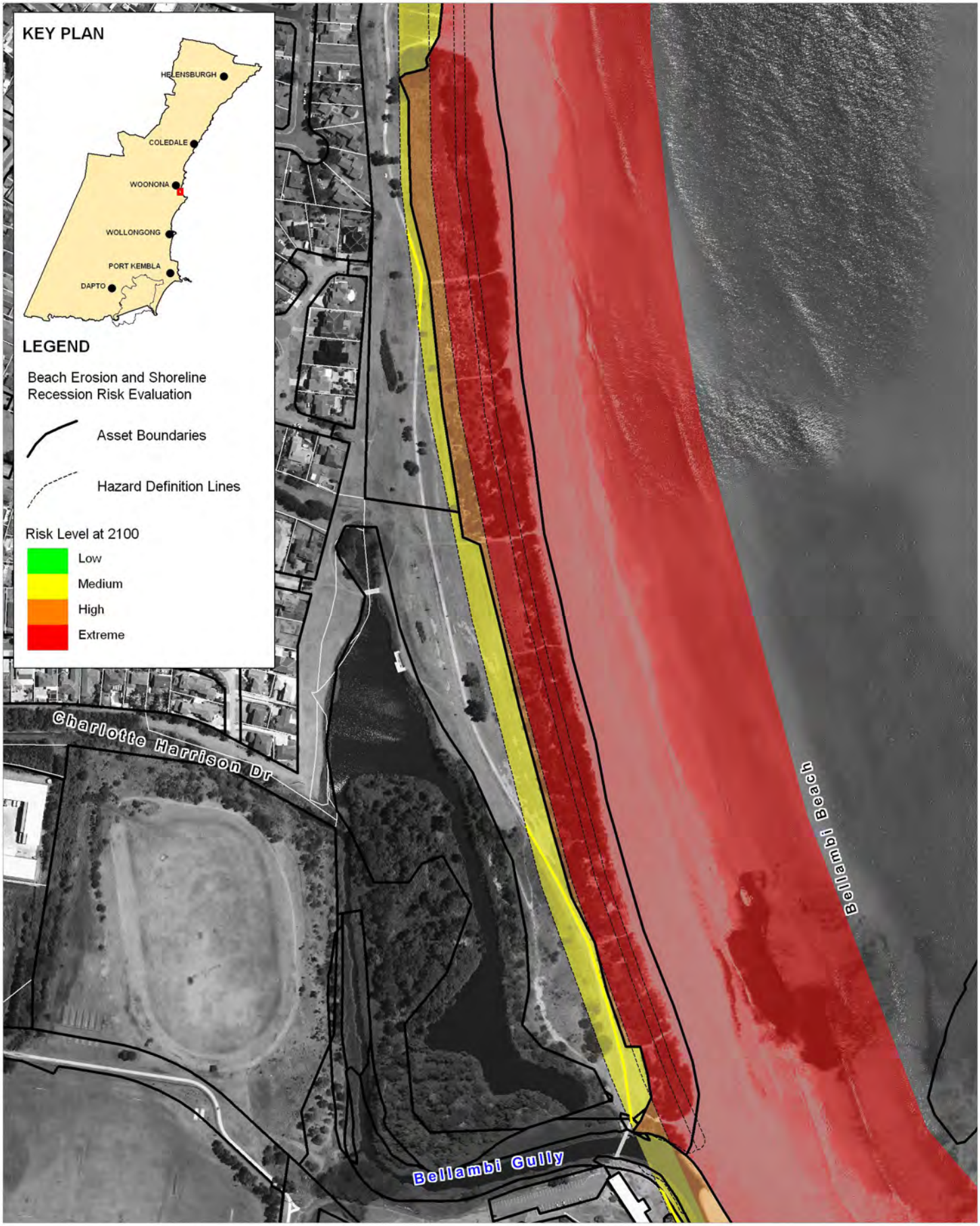
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_171_110415 Drawing C-11.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Bellambi Beach

Drawing: C-12

Rev: A

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N

0 75 150m

Approx. Scale

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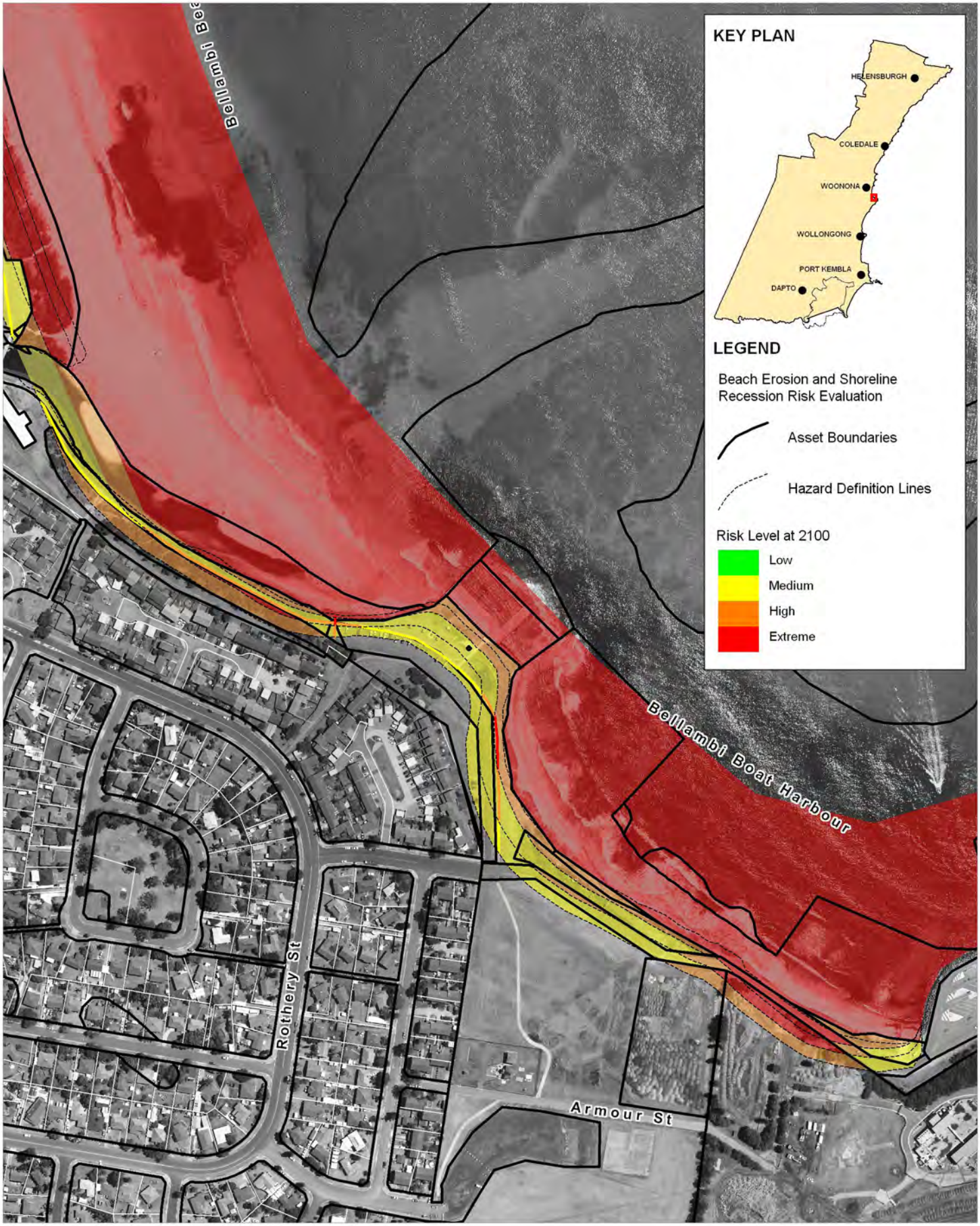
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_172_110415 Drawing C-12.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Bellambi Boat Harbour

Drawing: C-13

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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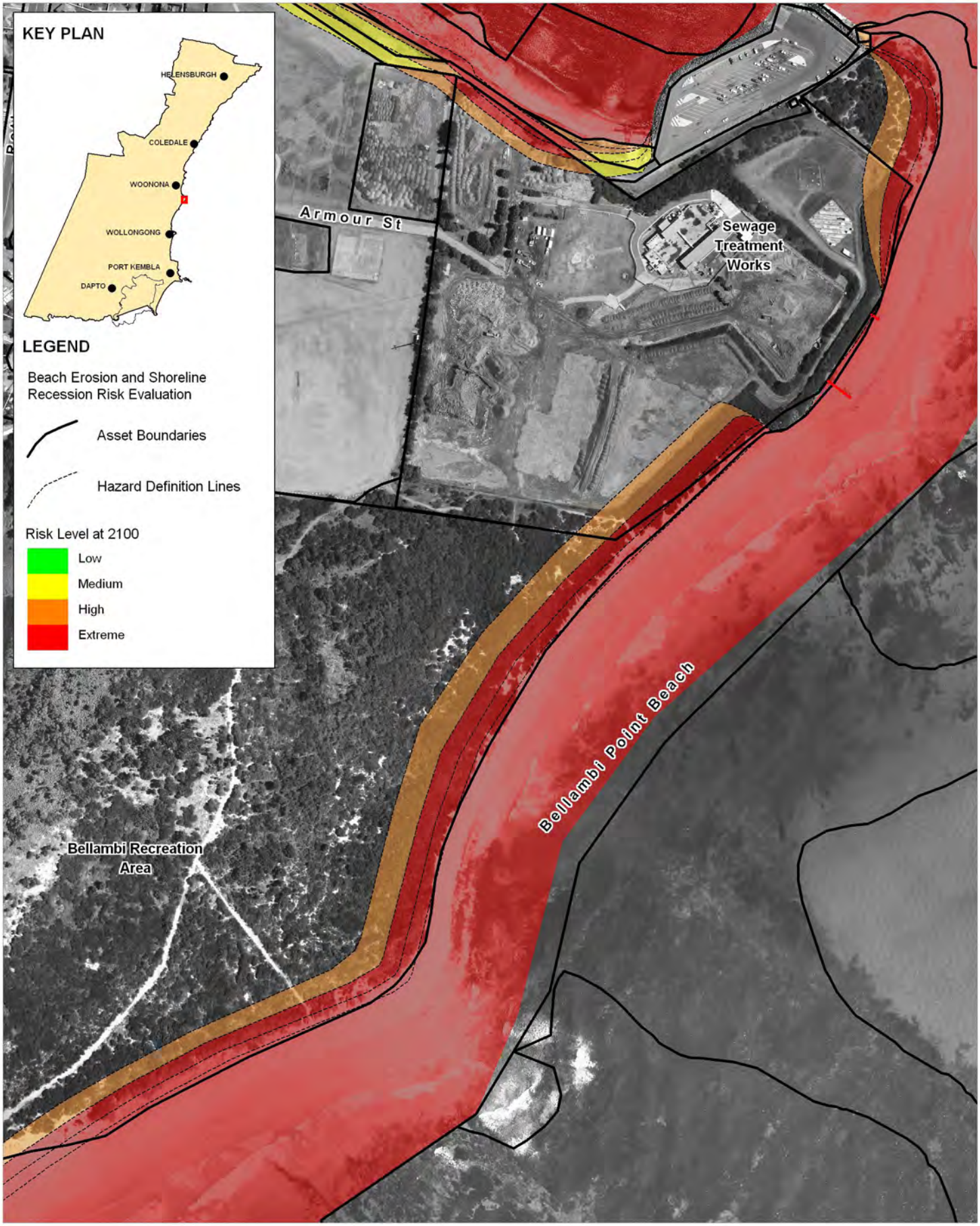
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_173_110415 Drawing C-13.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Bellambi Point Beach

Drawing: C-14

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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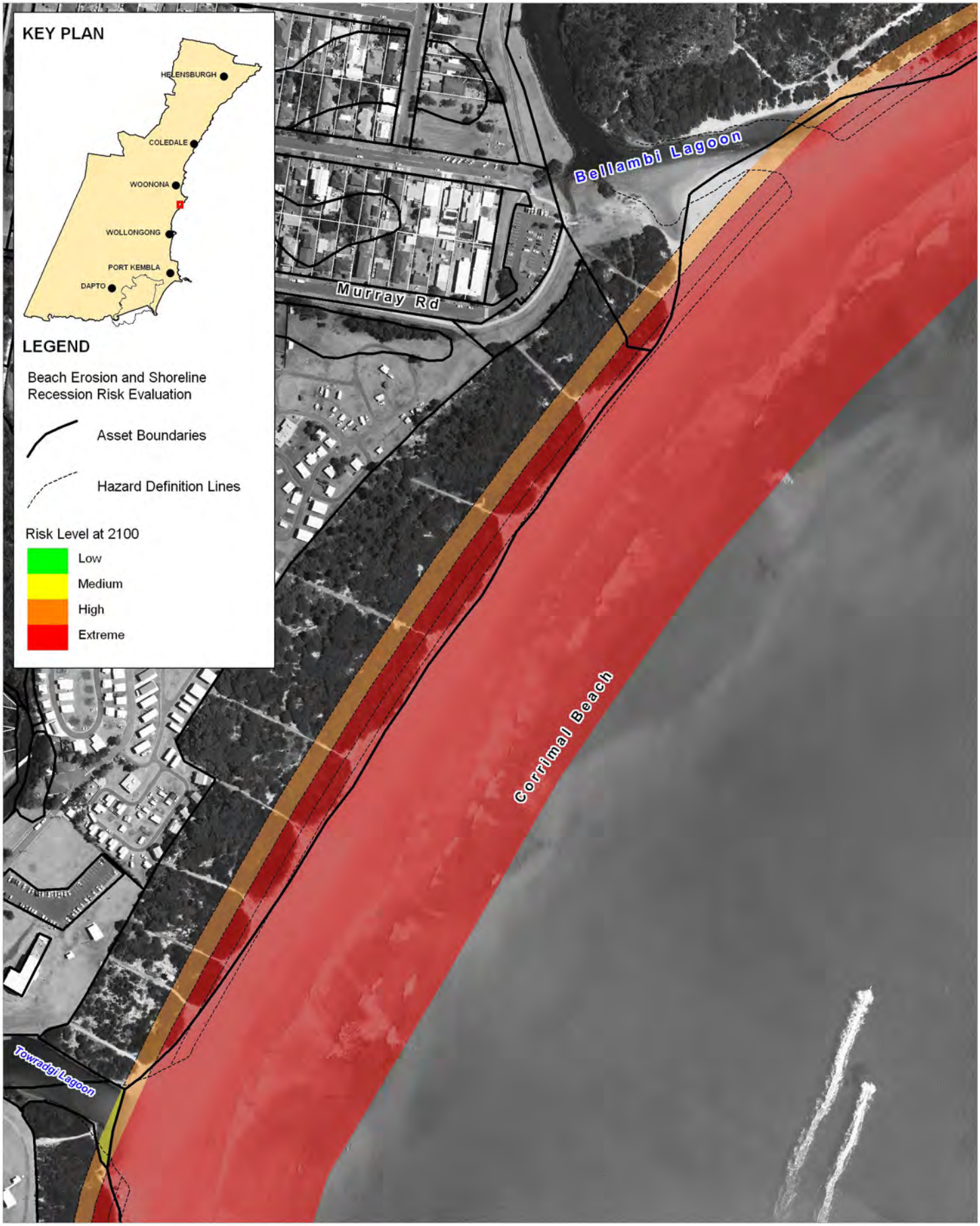
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_174_110415 Drawing C-14.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Corrimal Beach

Drawing: C-15

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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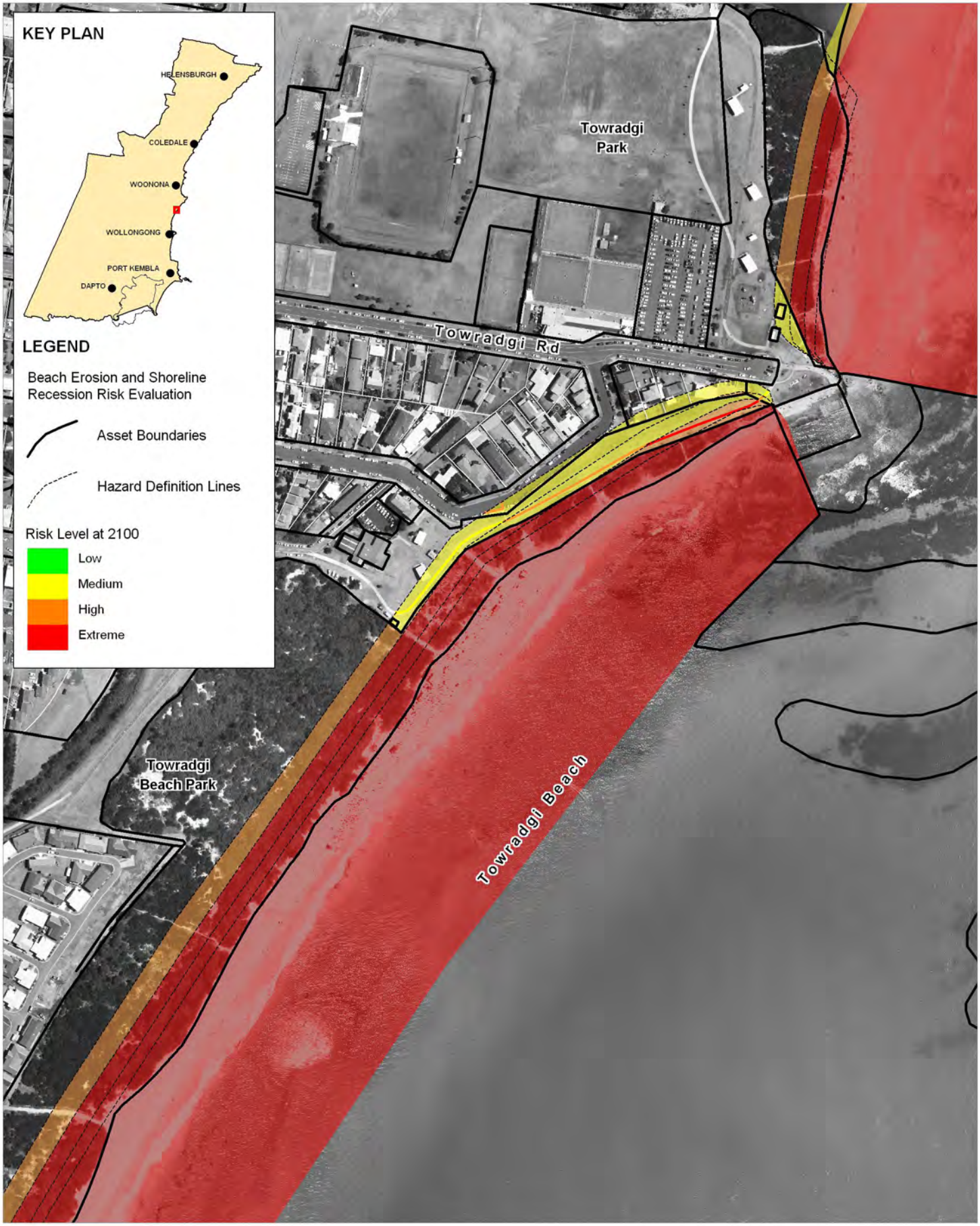
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_175_110415 Drawing C-15.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Towradgi Beach

Drawing: C-16

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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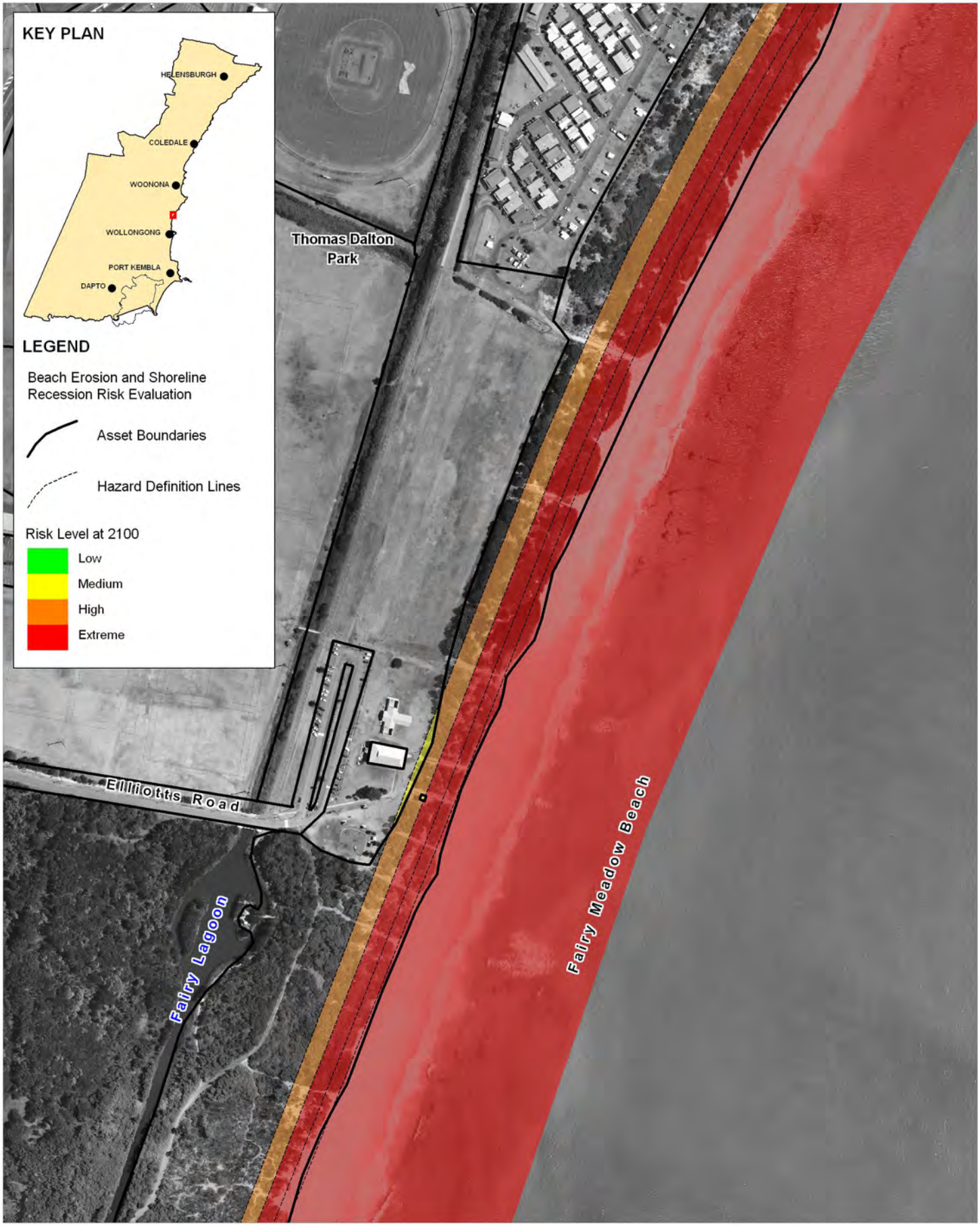
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_176_110415 Drawing C-16.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Fairy Meadow Beach (north)

Drawing: C-17

Rev: A

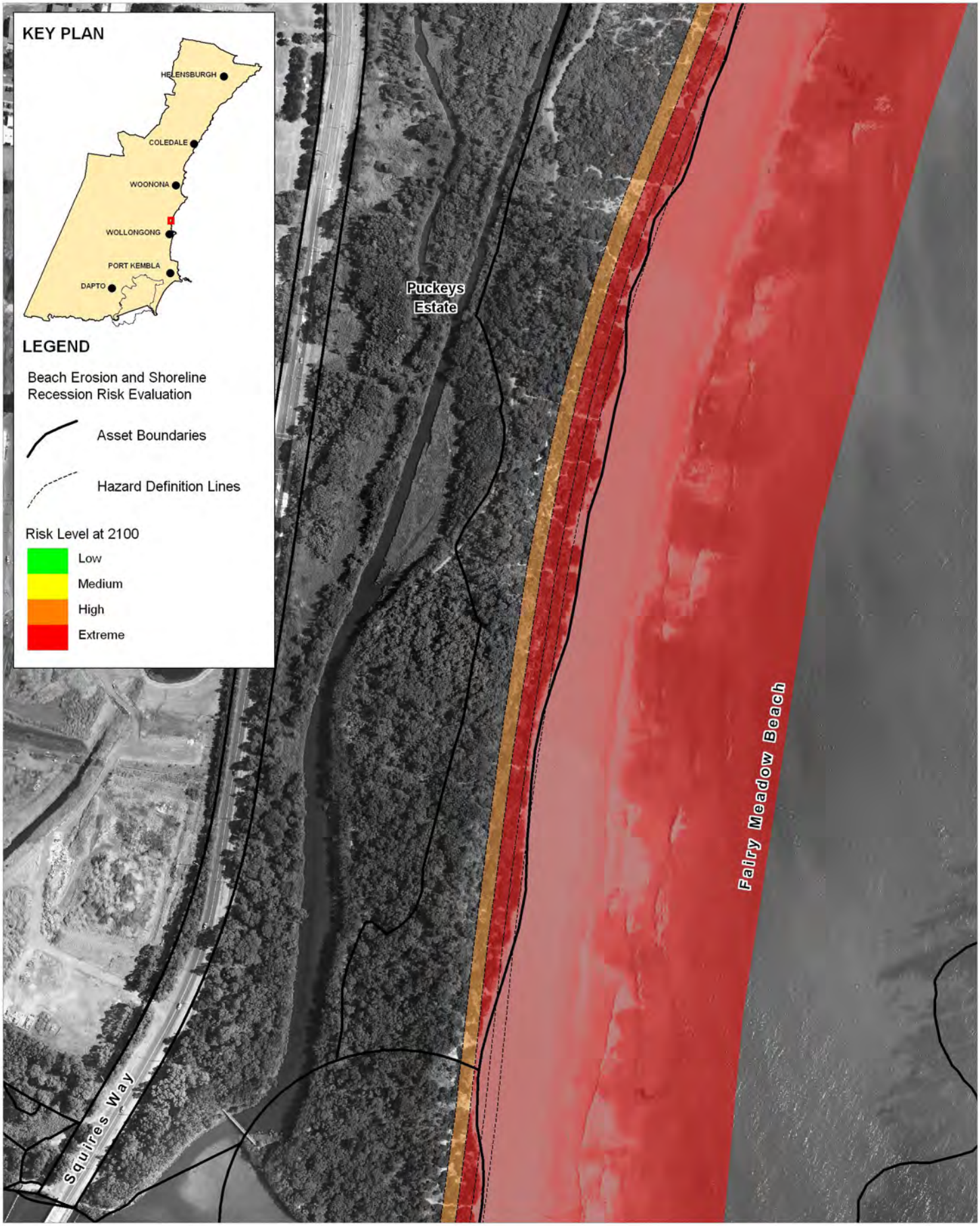
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_177_110415 Drawing C-17.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Fairy Meadow Beach (south)

Drawing: C-18

Rev: A

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N

0 75 150m

Approx. Scale

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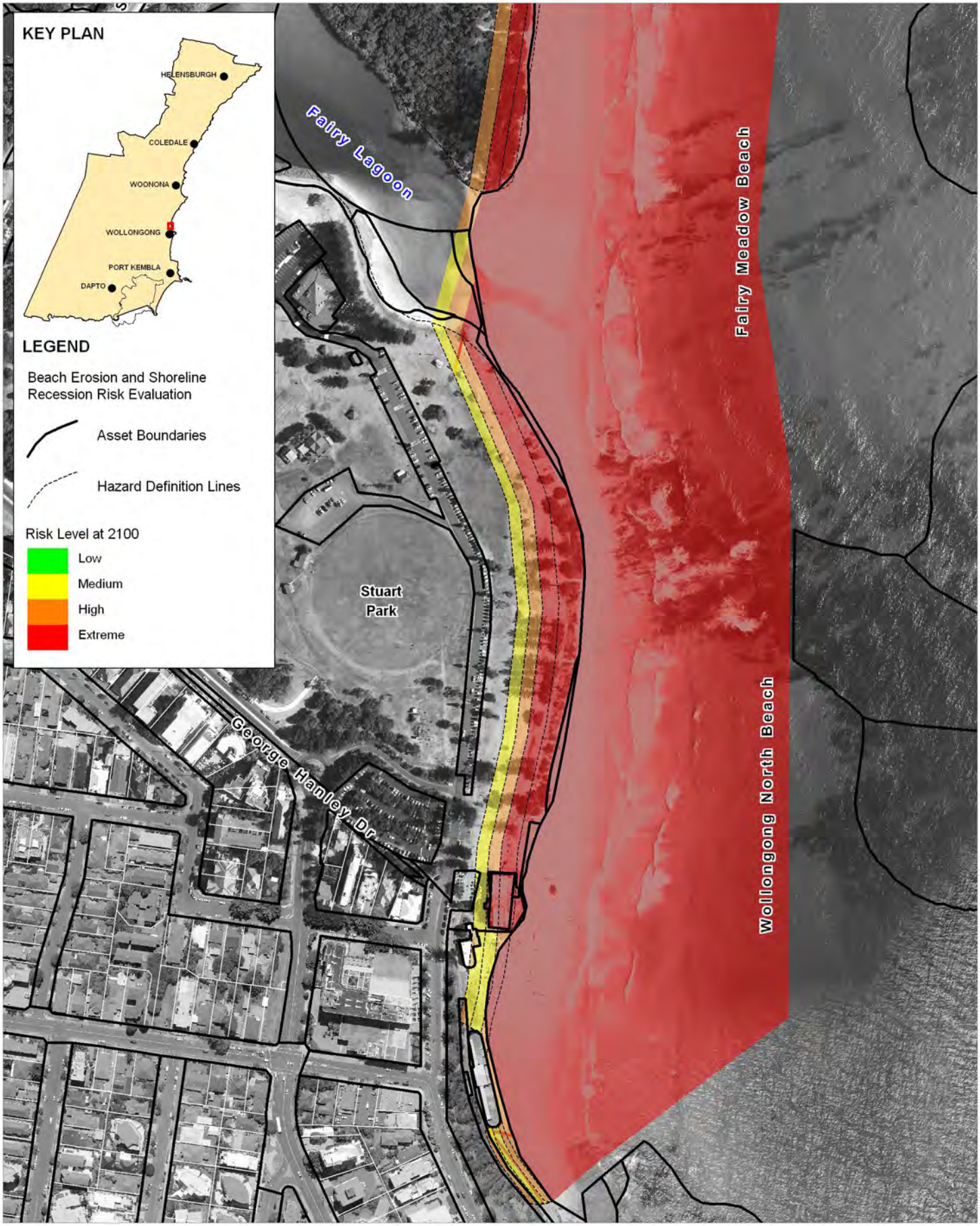
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_178_110415 Drawing C-18.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Wollongong North Beach

Drawing: C-19

Rev: A

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N

0 75 150m

Approx. Scale

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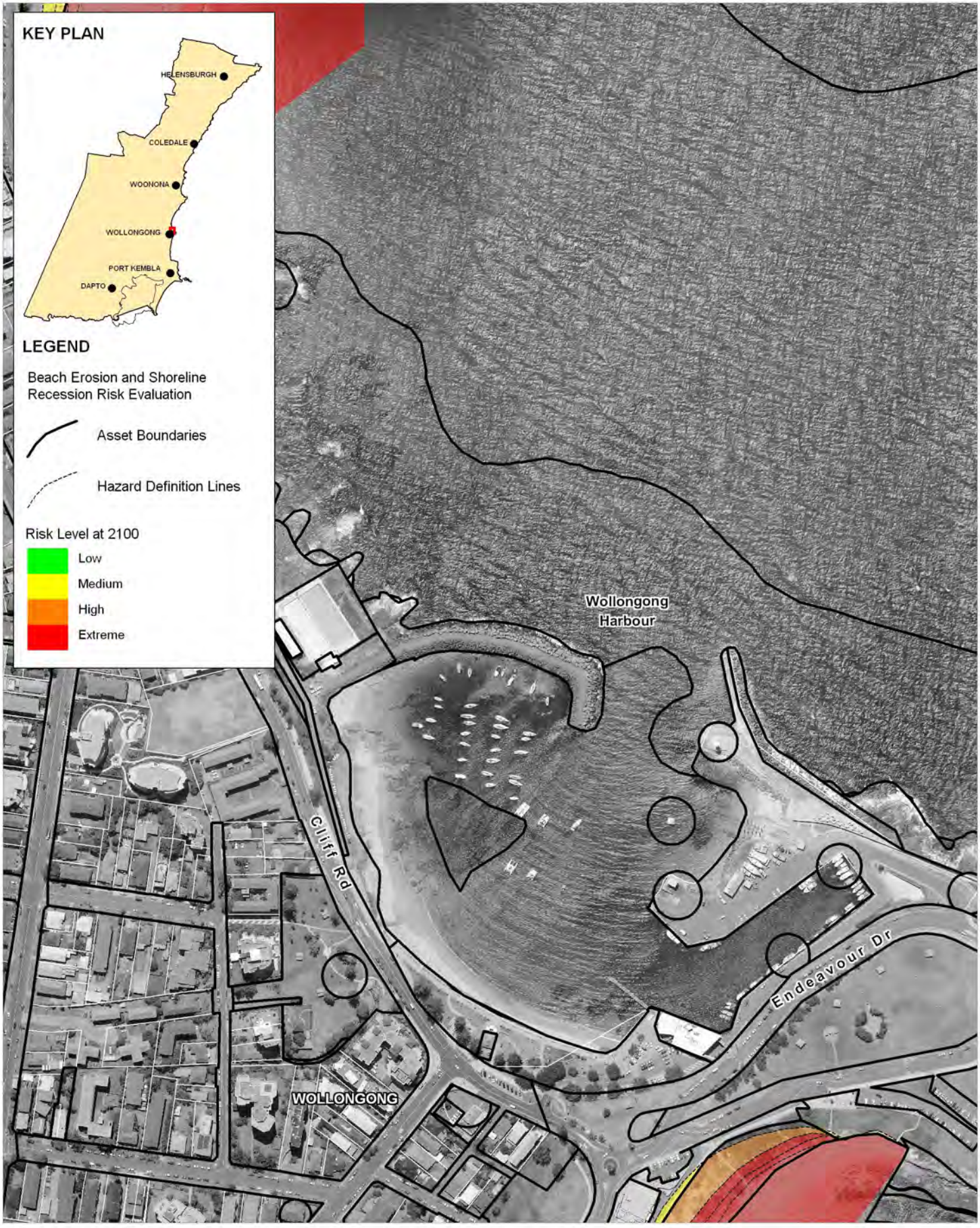
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_179_110415 Drawing C-19.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Wollongong Harbour

Drawing: C-20

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
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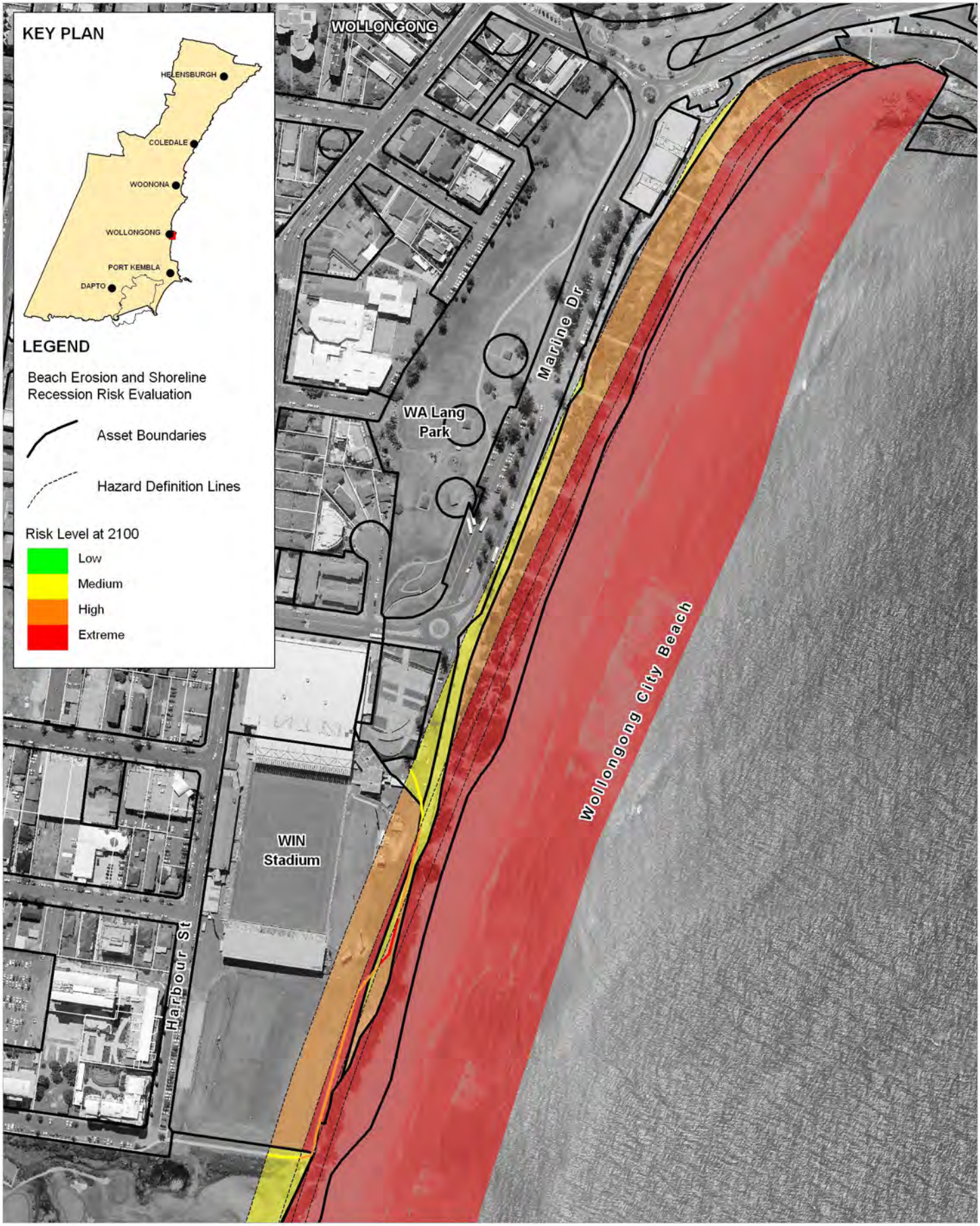
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_180_110415 Drawing C-20.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Wollongong City Beach

Drawing: C-21

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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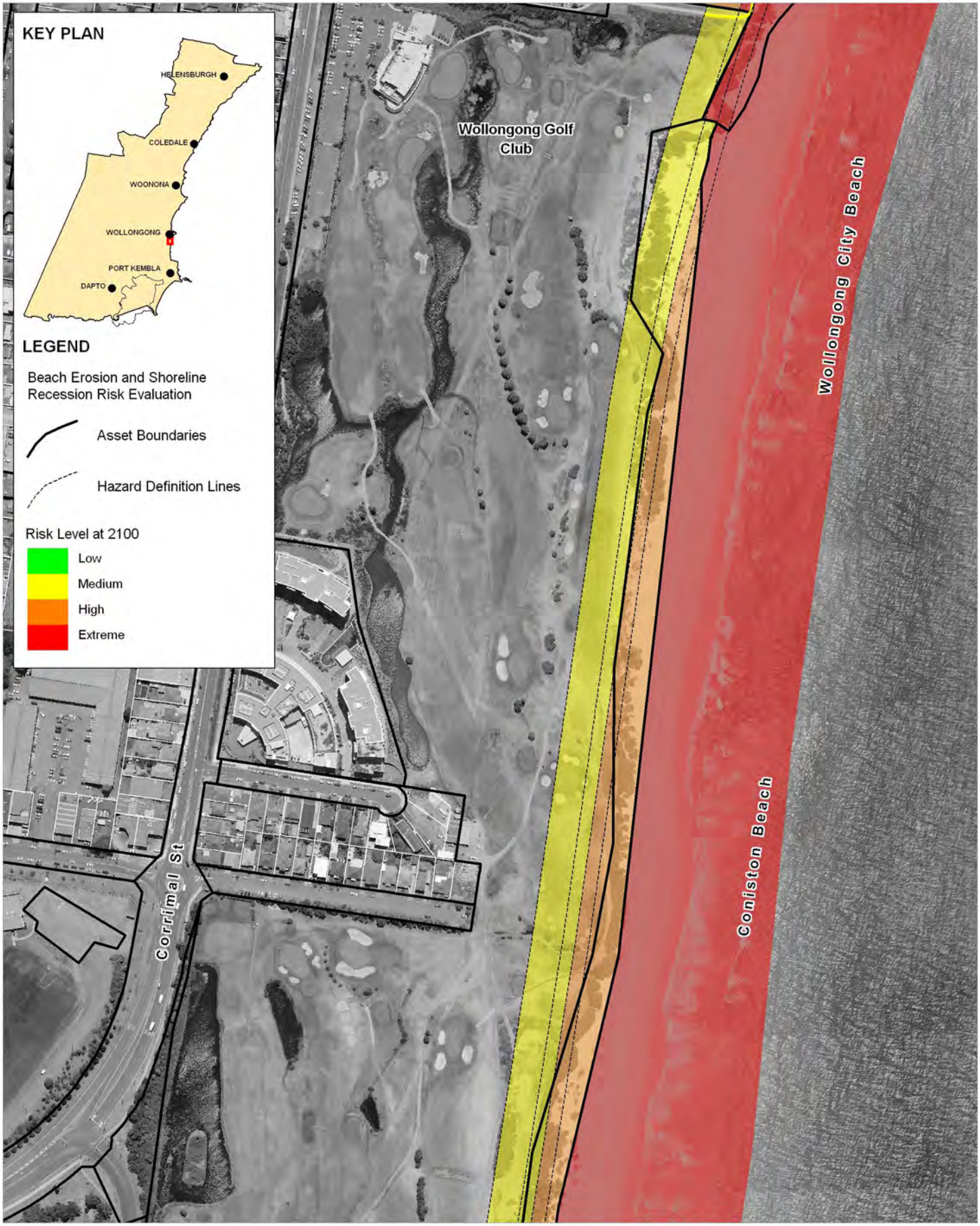
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_181_110418 Drawing C-21.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Coniston Beach (north)

Drawing: C-22

Rev: A

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N

0 75 150m

Approx. Scale

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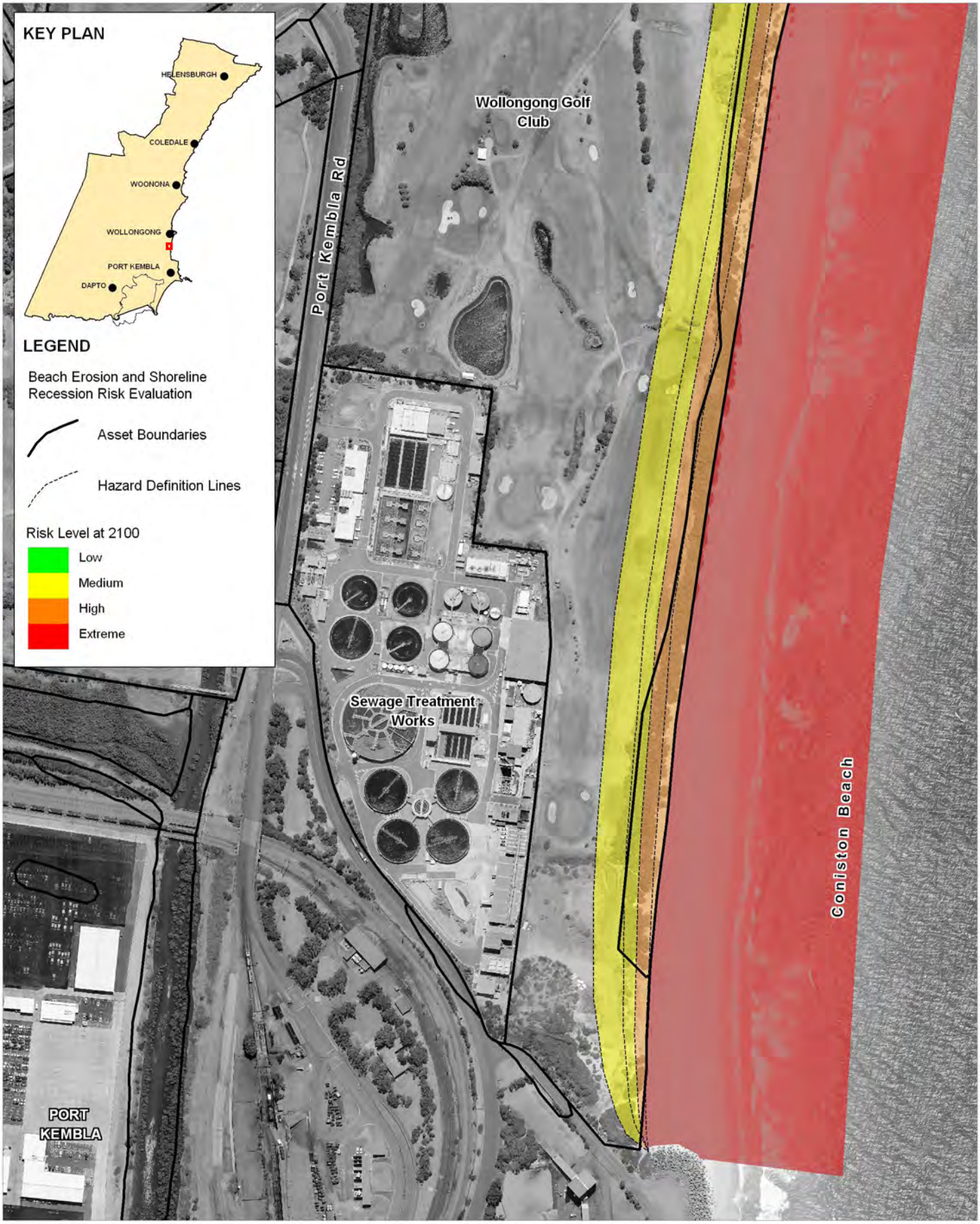
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_182_110418 Drawing C-22.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Coniston Beach (south)

Drawing: C-23

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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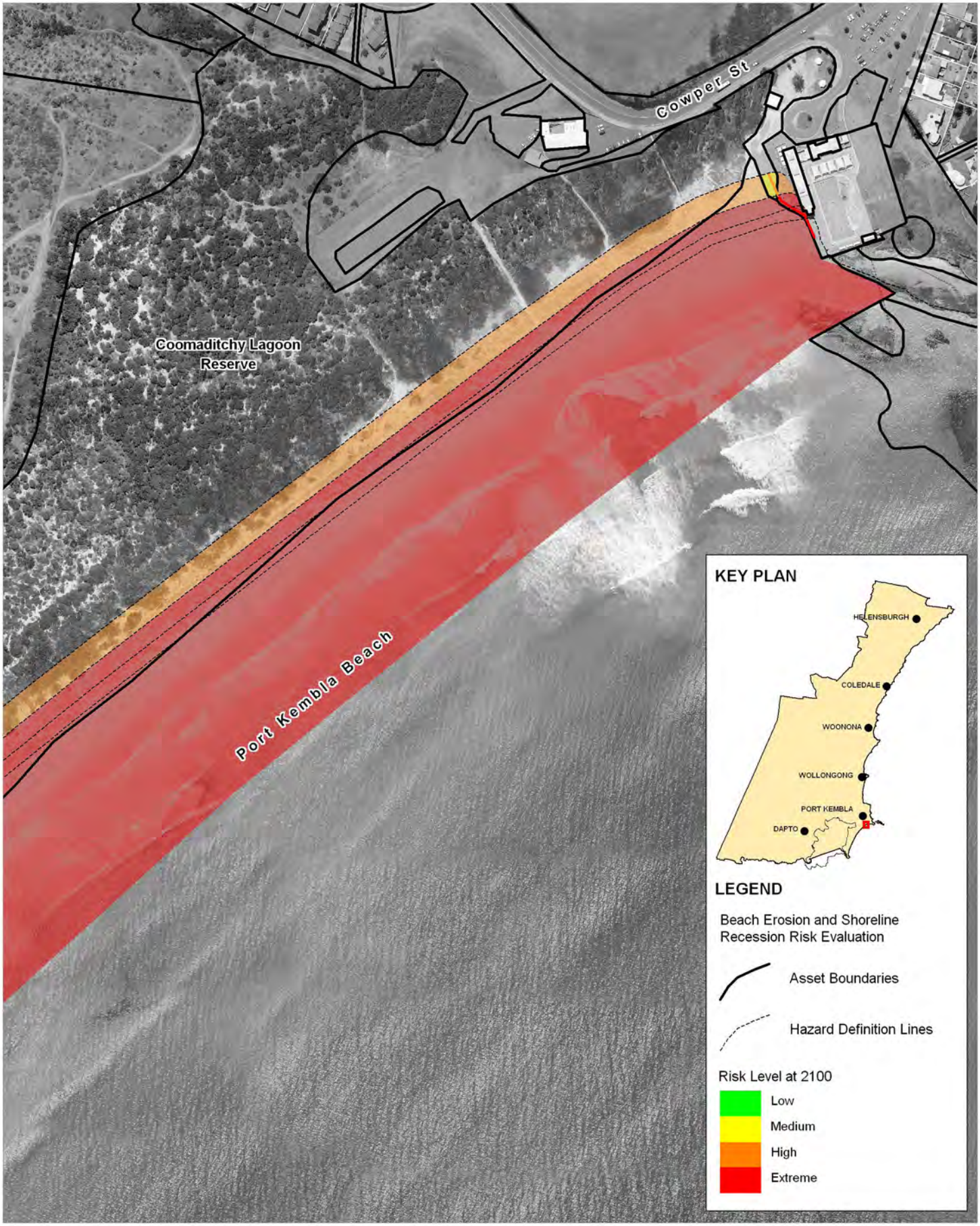
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_183_110418 Drawing C-23.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Port Kembla Beach

Drawing: C-24

Rev: A

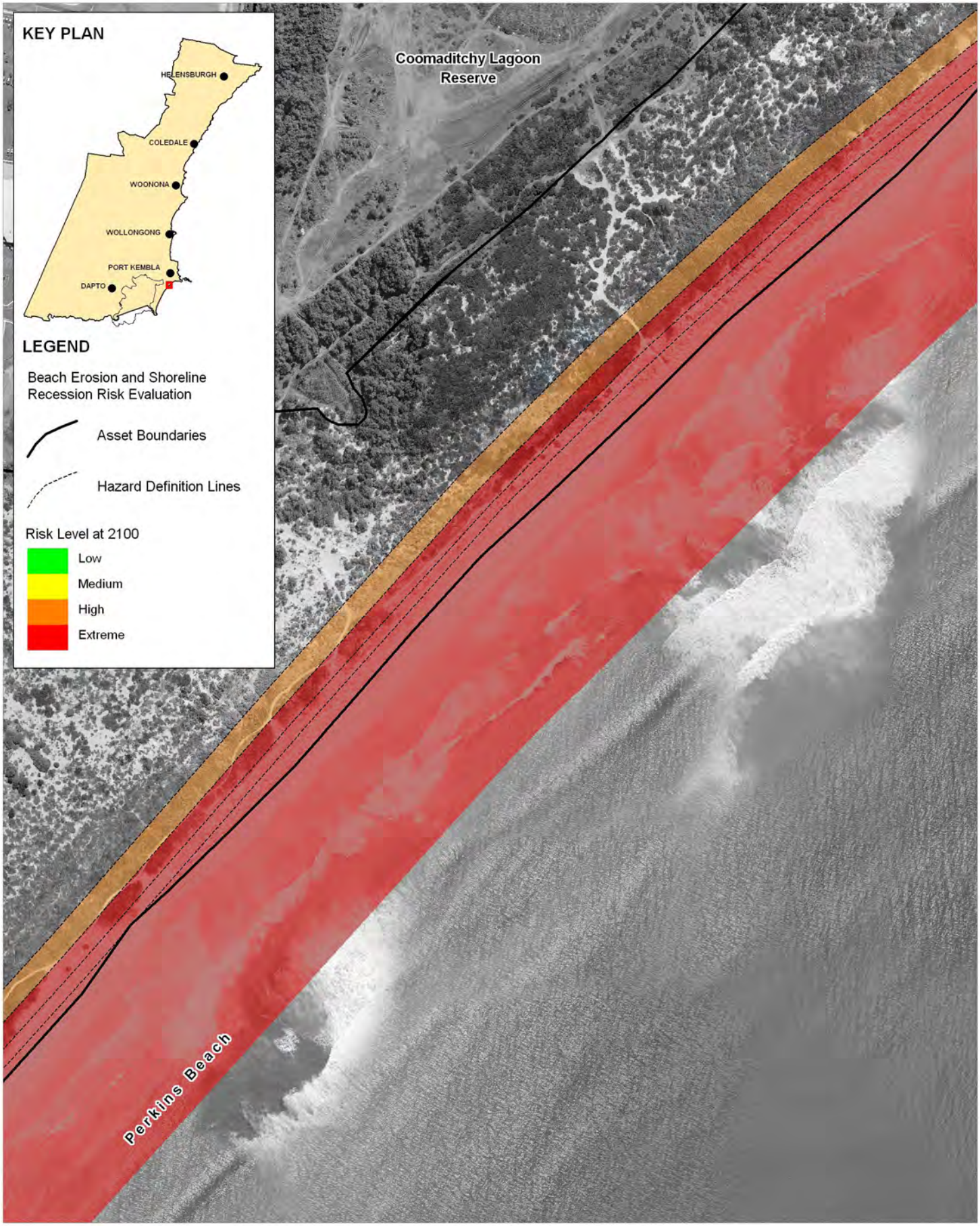
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_184_110418 Drawing C-24.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Perkins Beach (1)

Drawing: C-25

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

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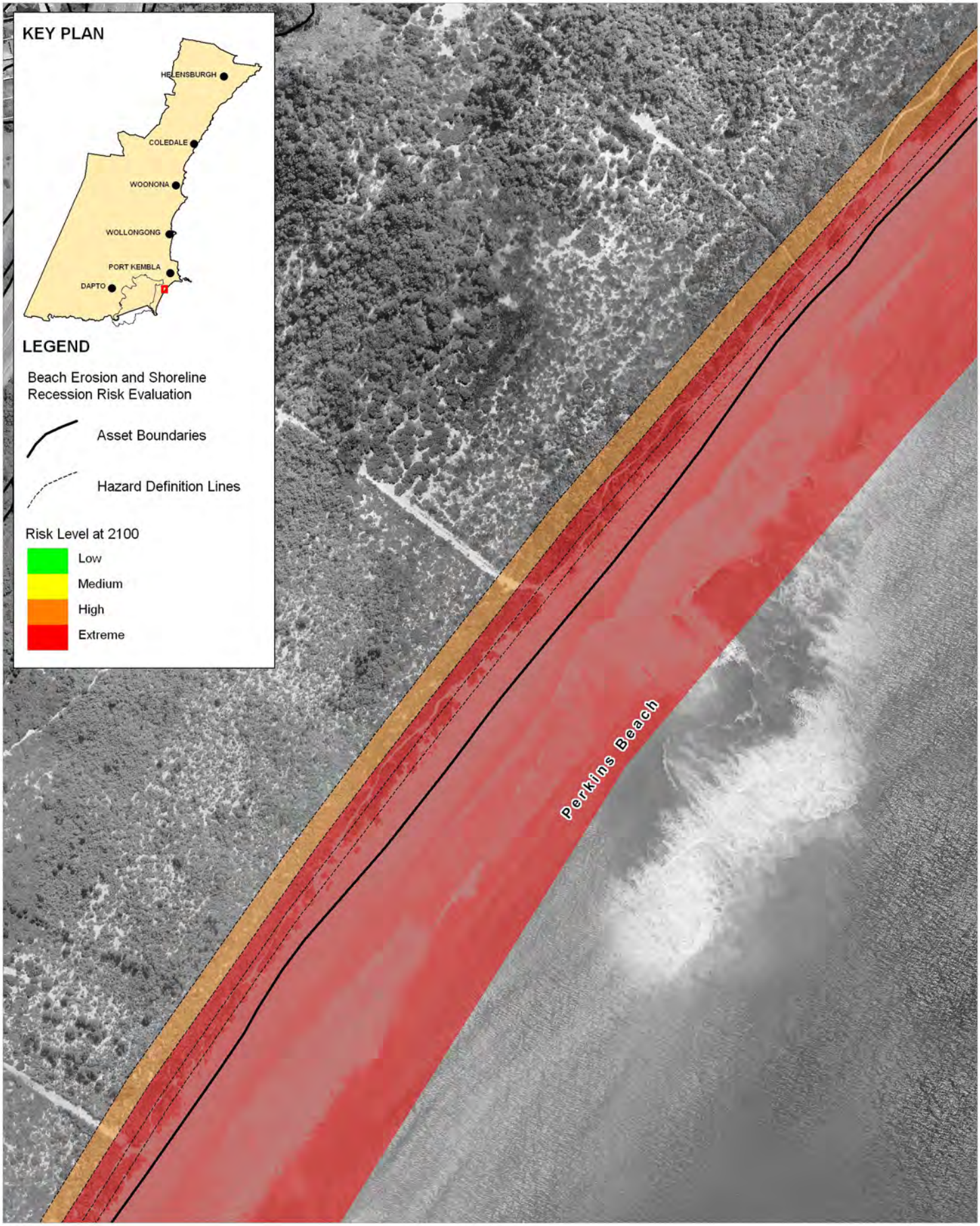
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_185_110418 Drawing C-25.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Perkins Beach (2)

Drawing: C-26

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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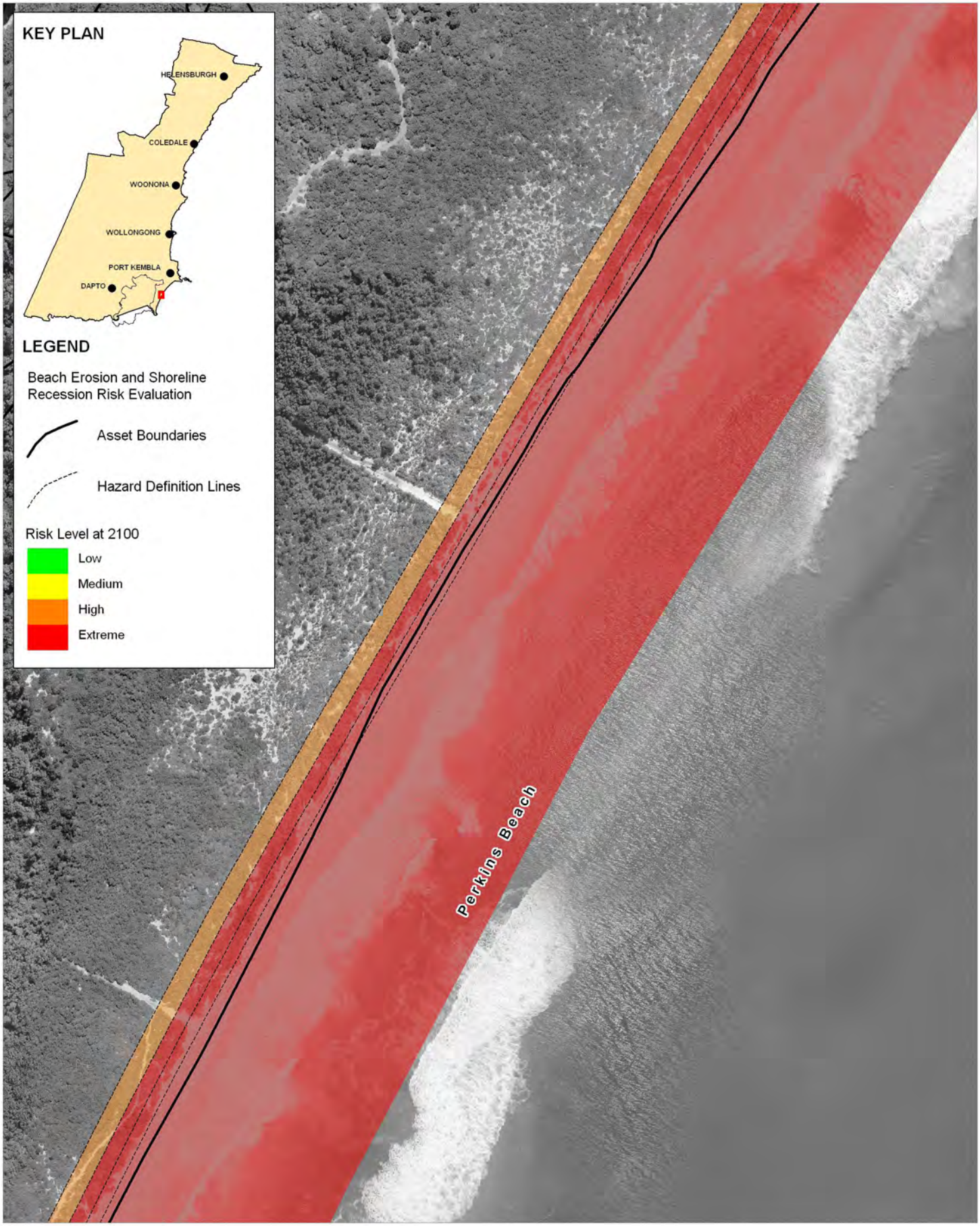
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_186_110418 Drawing C-26.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Perkins Beach (3)

Drawing: C-27

Rev: A

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N

0 75 150m

Approx. Scale

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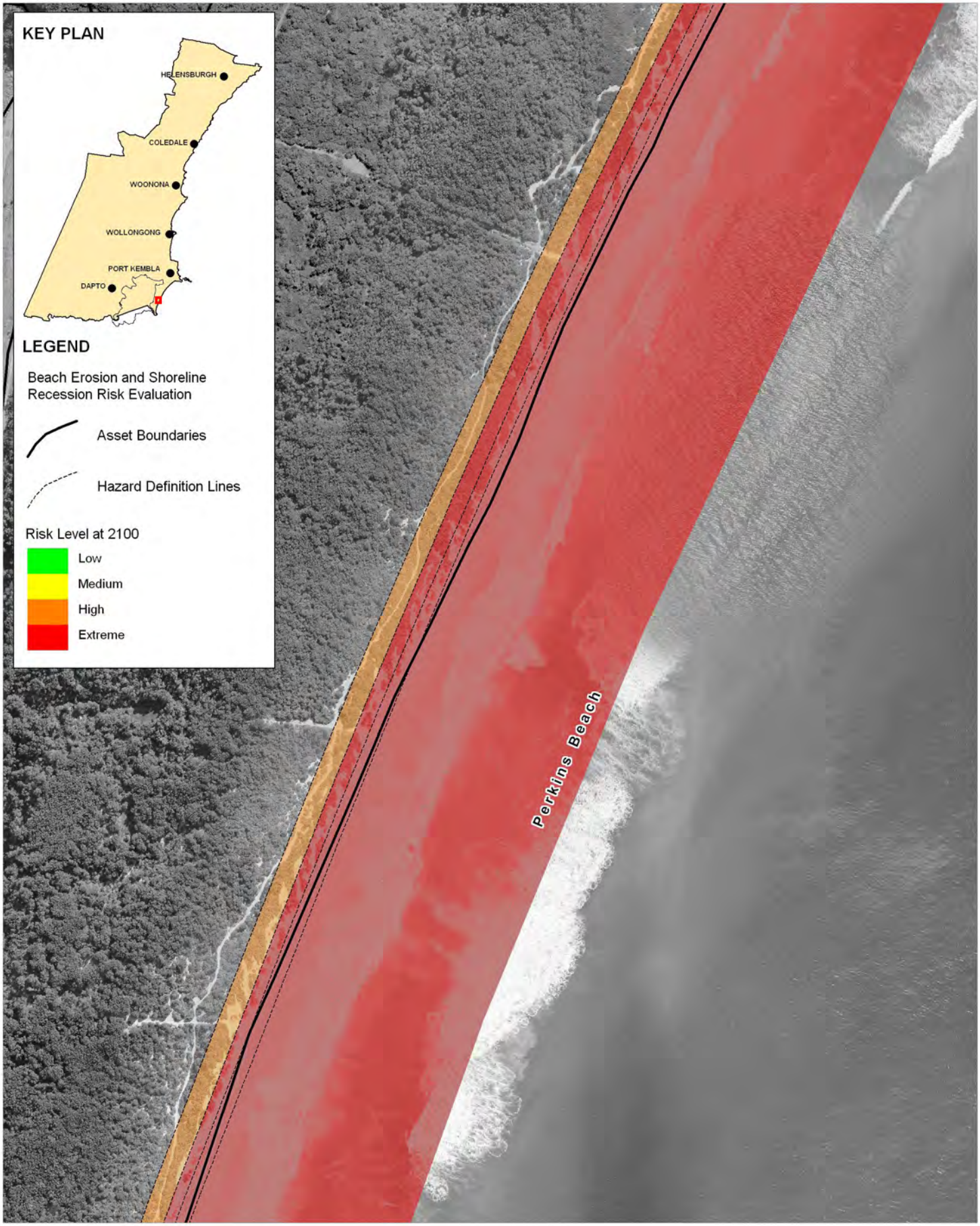
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_187_110418 Drawing C-27.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Perkins Beach (4)

Drawing: C-28

Rev: A

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N

0 75 150m

Approx. Scale

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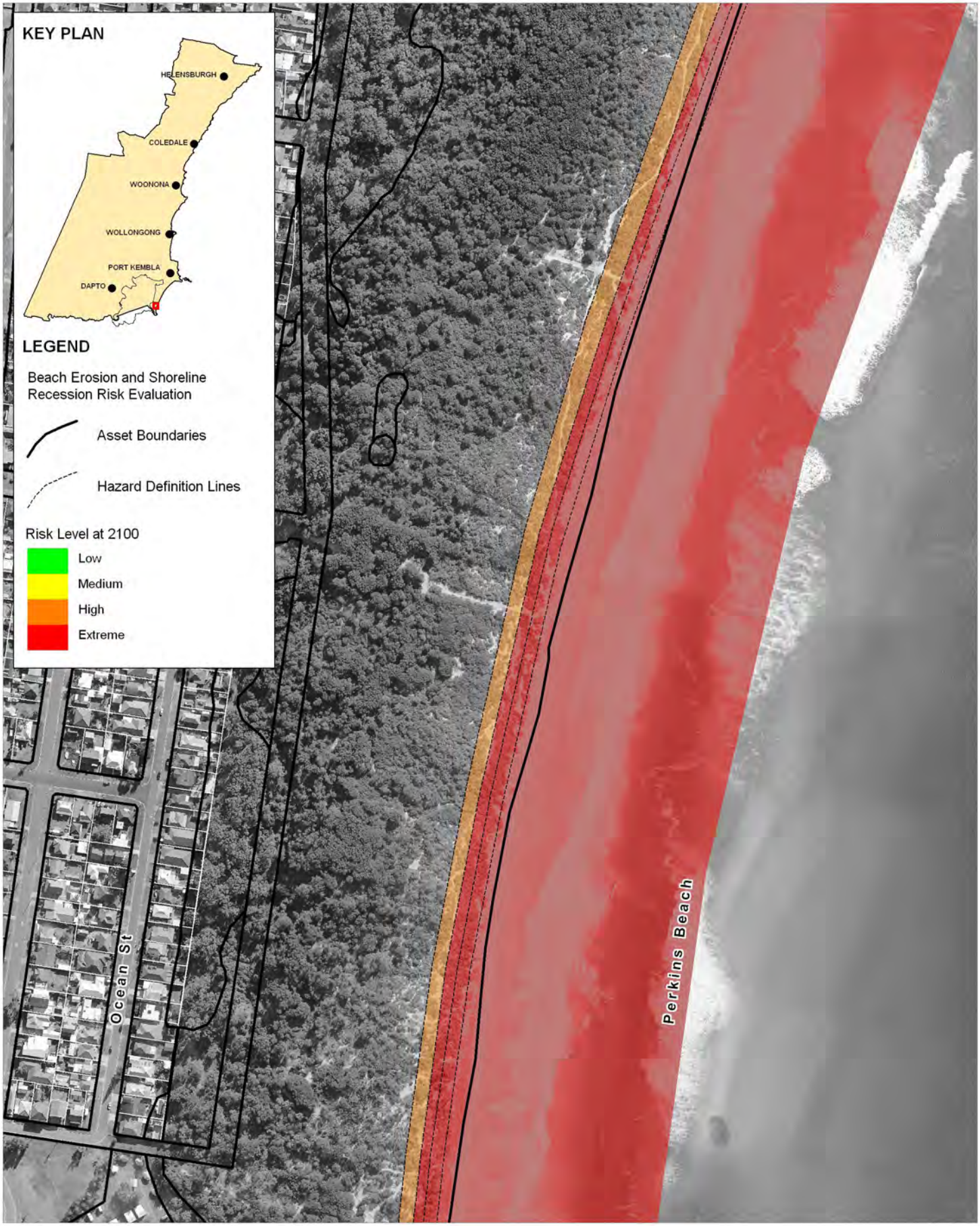
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_188_110418 Drawing C-28.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Perkins Beach (5)

Drawing: C-29

Rev: A

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N

0 75 150m

Approx. Scale

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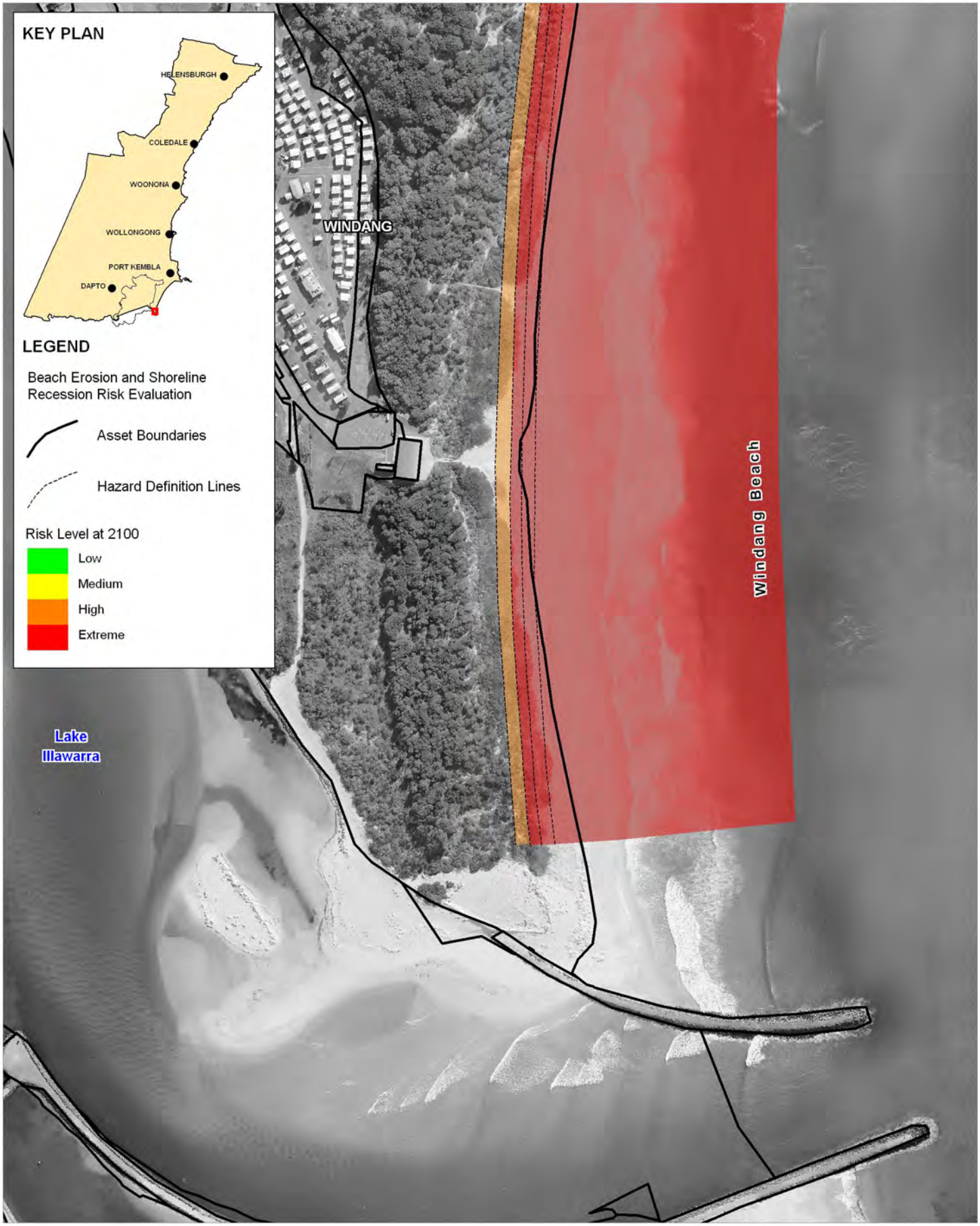
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_189_110418 Drawing C-29.WOR



Title:

Erosion and Recession Risk Evaluation
2100 Planning Horizon - Windang Beach

Drawing: C-30

Rev: A

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N

0 75 150m

Approx. Scale

BMT WBM
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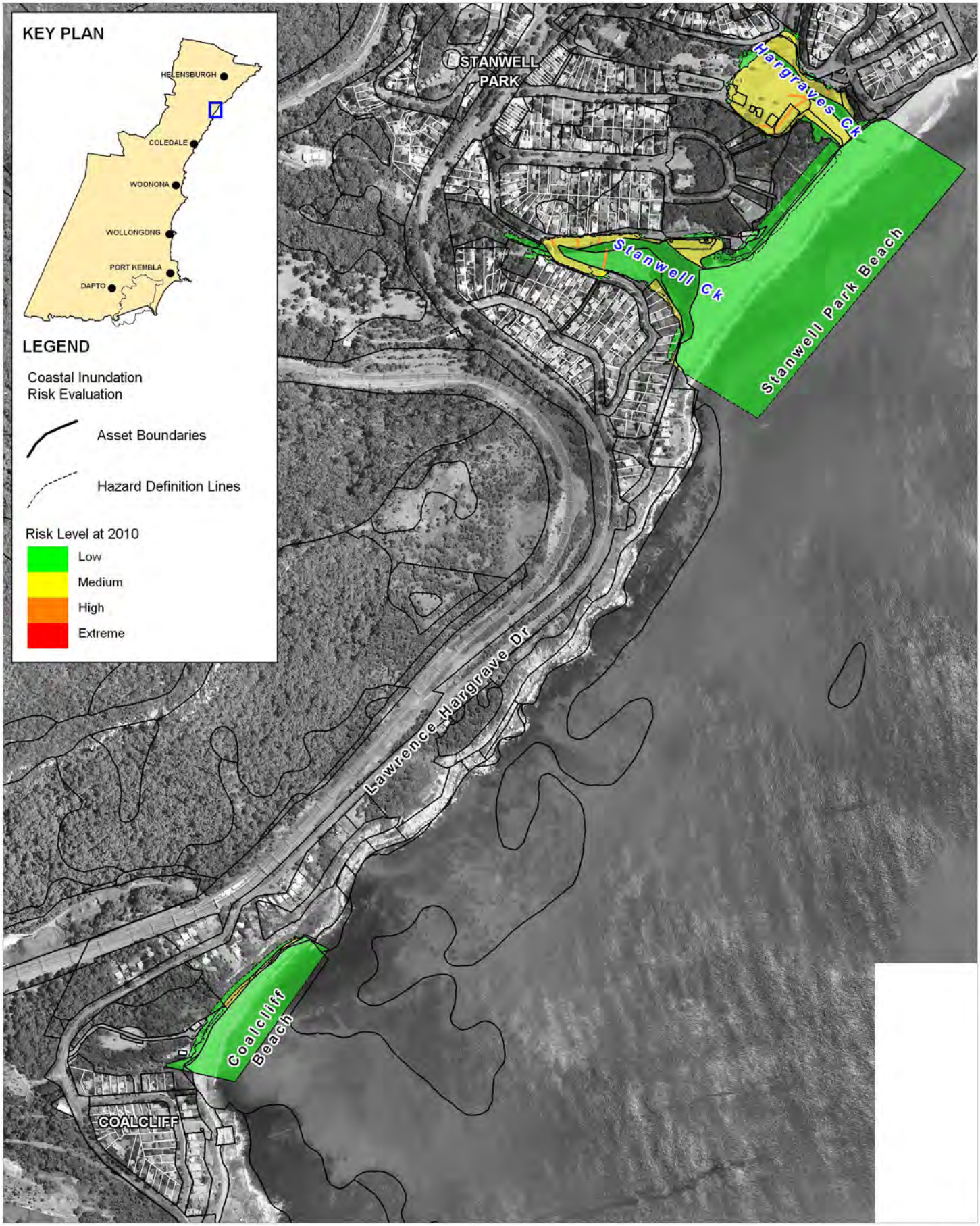
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_190_110418 Drawing C-30.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Stanwell Park / Coalcliff

Drawing: D-1

Rev: A

N

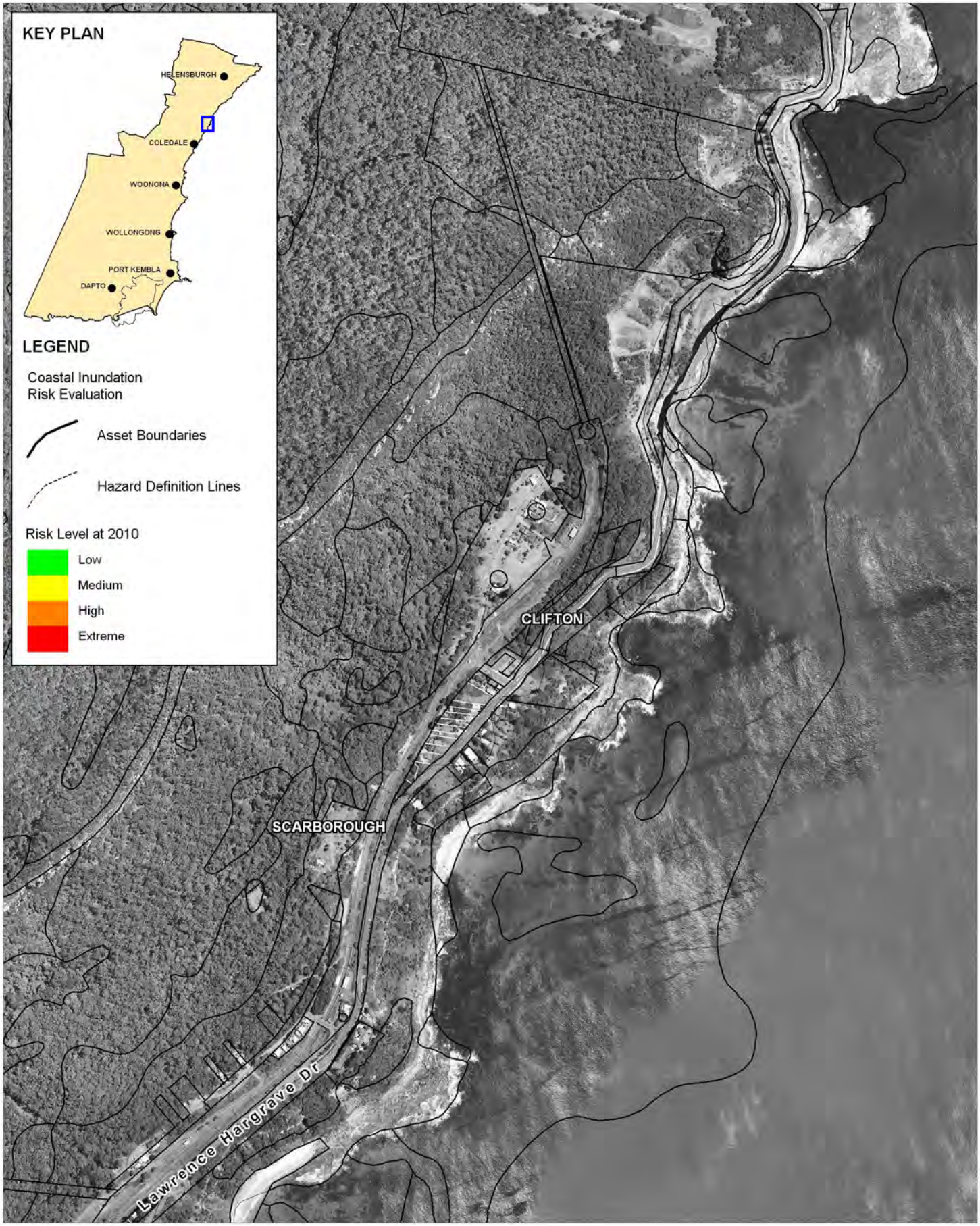
0 200 400m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_191_110419 Drawing D-1.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Cliffton / Scarborough

Drawing: D-2

Rev: A

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N

0 200 400m

Approx. Scale

BMT WBM
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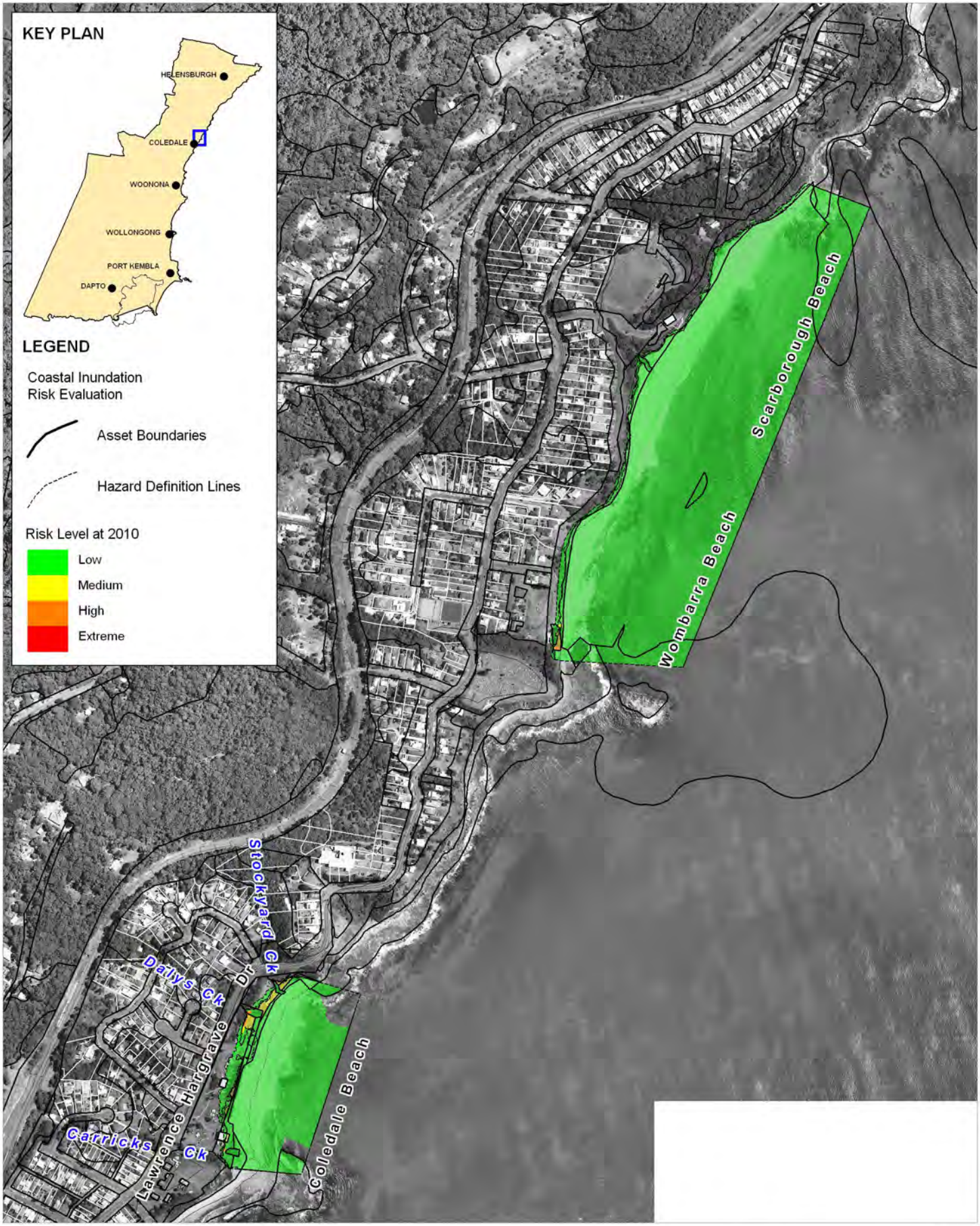
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_192_110419 Drawing D-2.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Scarborough/Coledale

Drawing: D-3

Rev: A

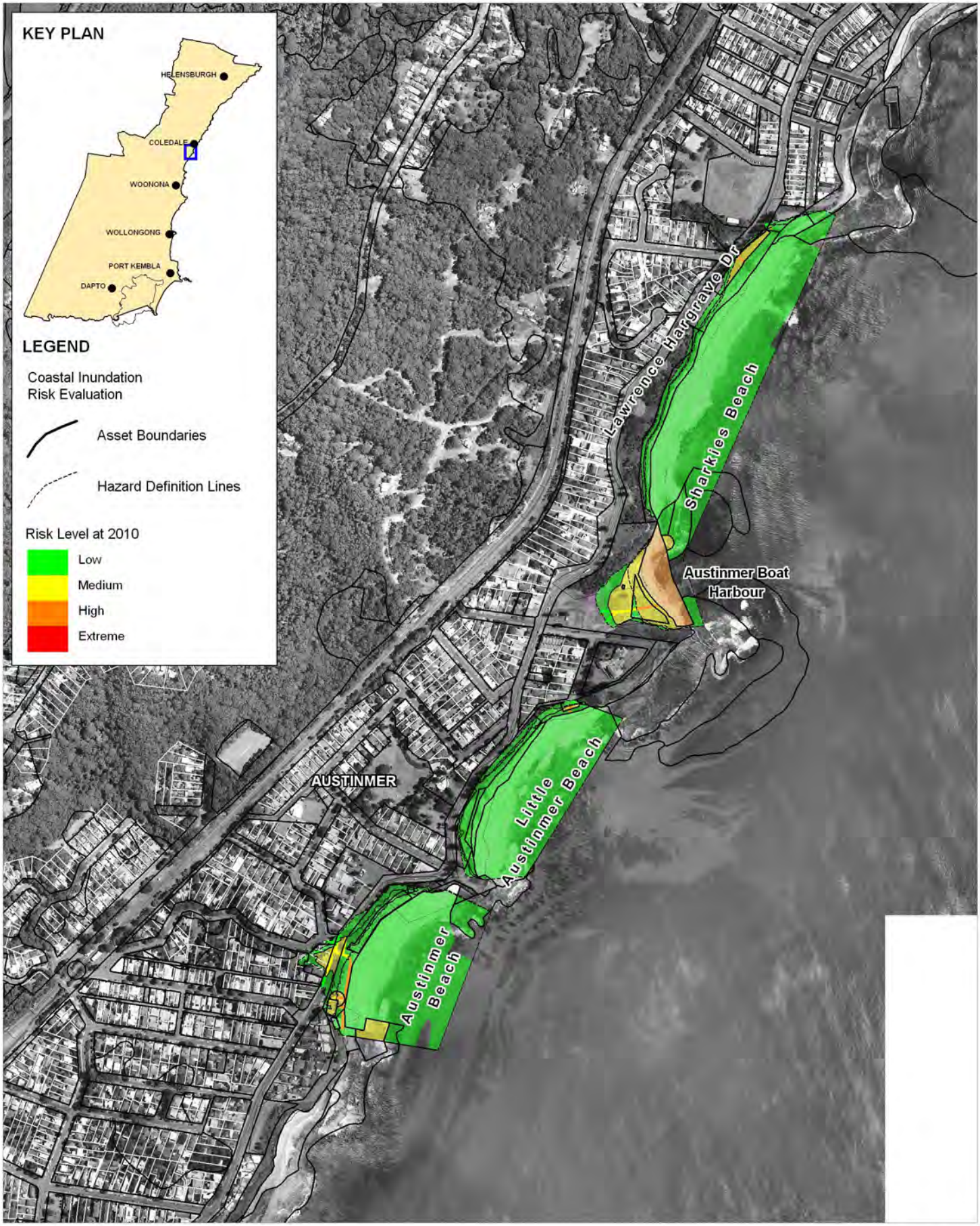
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_193_110419 Drawing D-3.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Austinmer

Drawing: D-4

Rev: A

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N

0 200 400m

Approx. Scale

BMT WBM
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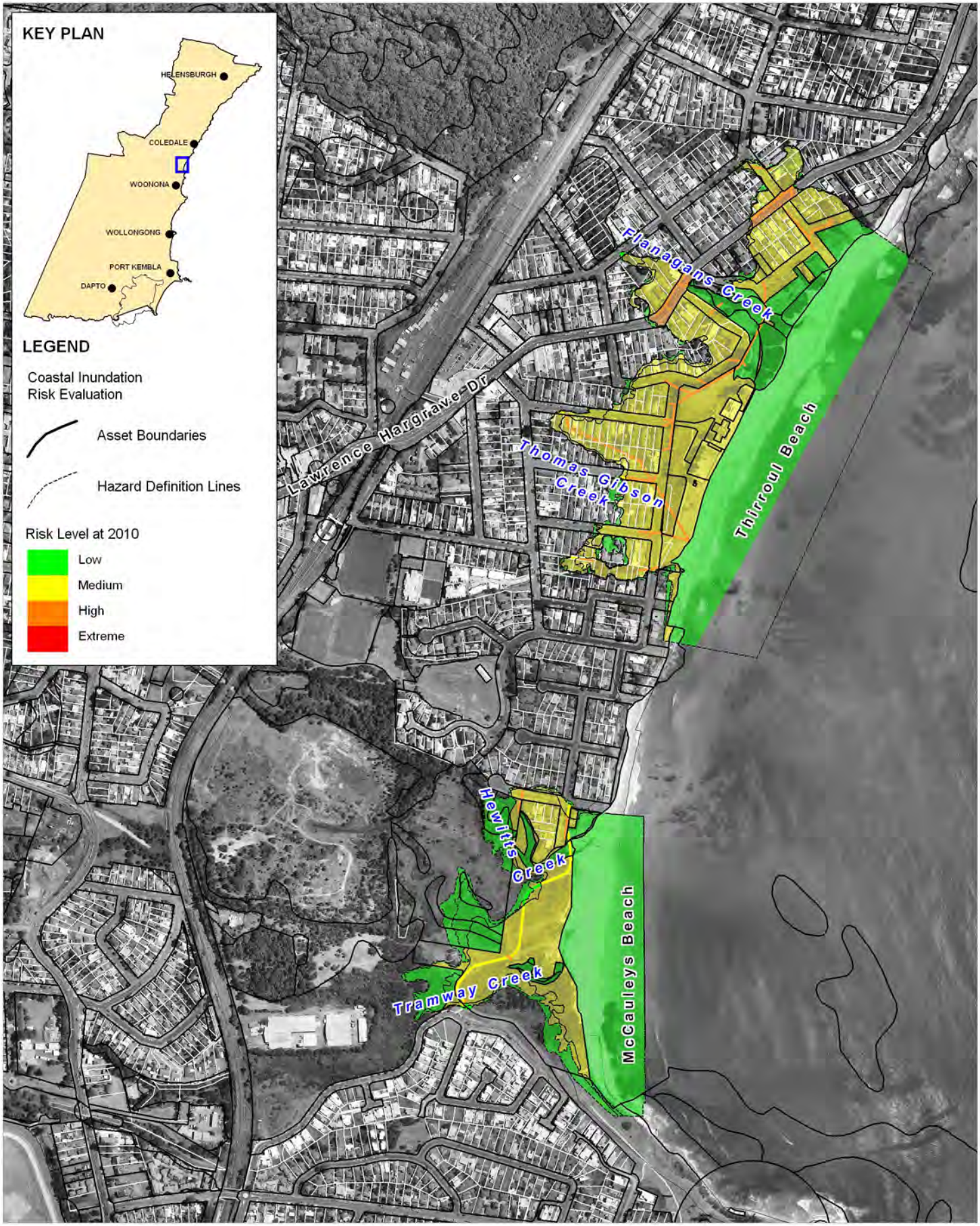
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_194_110419 Drawing D-4.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Thirroul/McCauleys

Drawing: D-5

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 200 400m

Approx. Scale

BMT WBM
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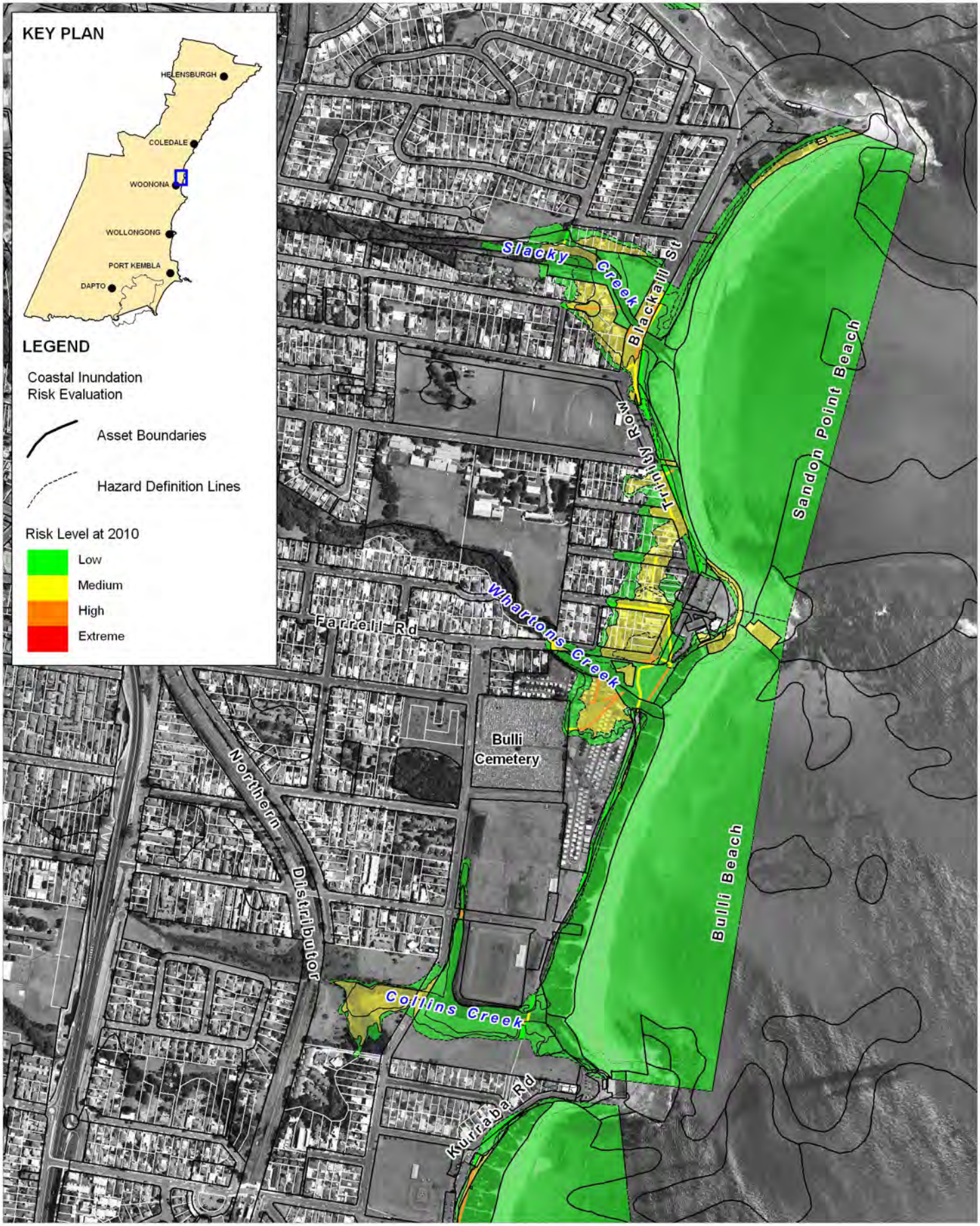

Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Sandon/Bulli

Drawing: D-6

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM

www.wbmpl.com.au

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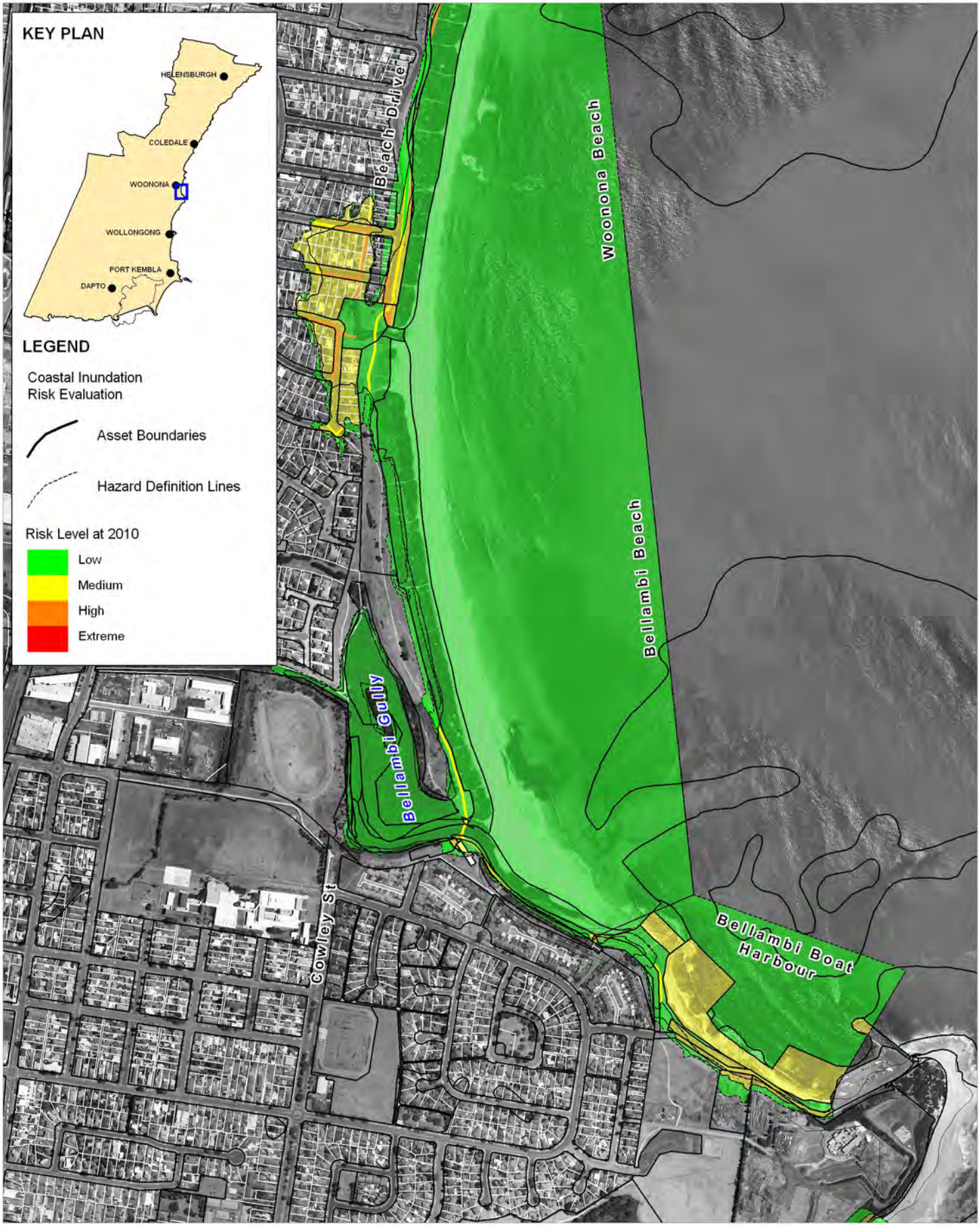


Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Woonona/Bellambi

Drawing: D-7

Rev: A

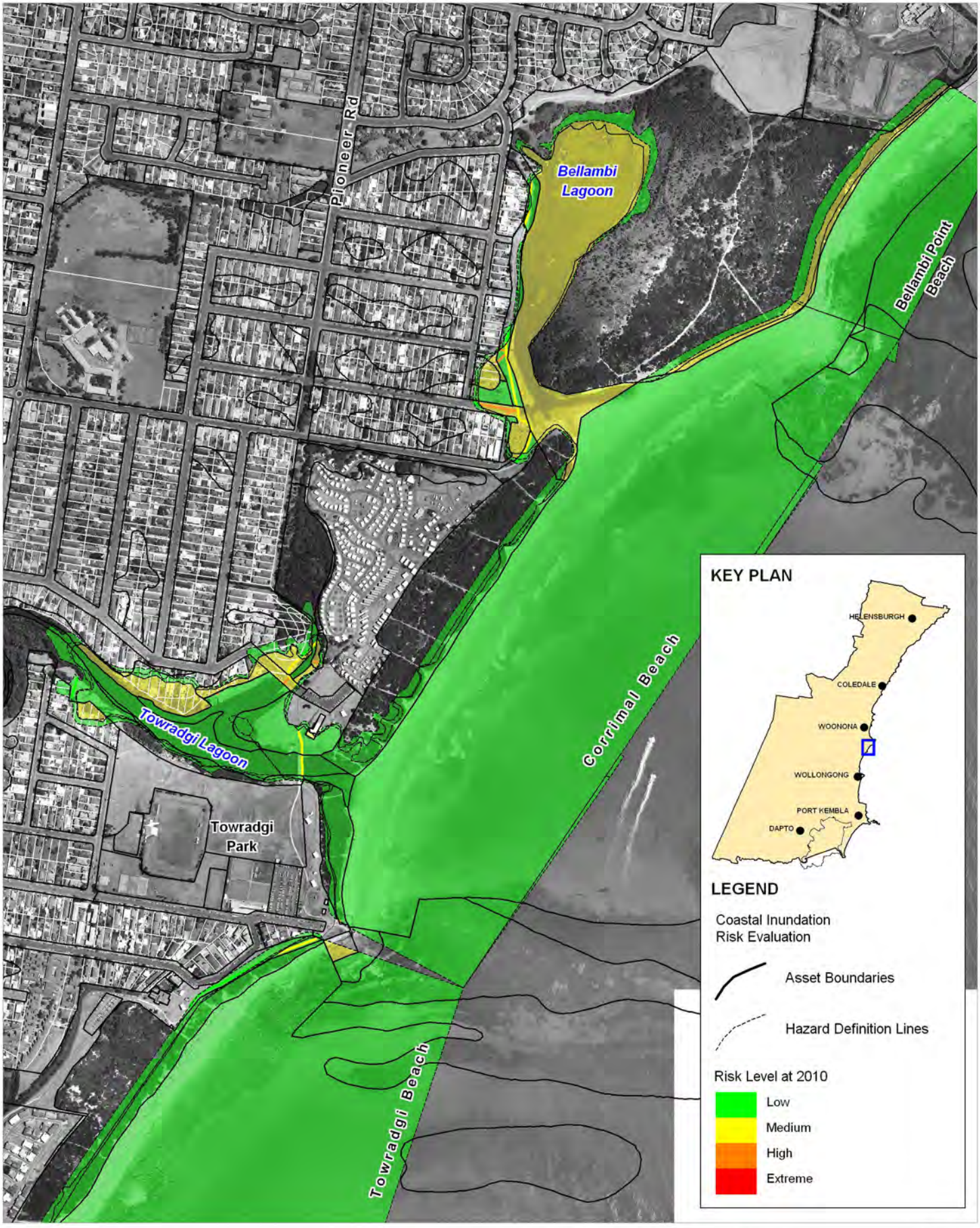
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_197_110419 Drawing D-7.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Corrimal Beach

Drawing: D-8

Rev: A

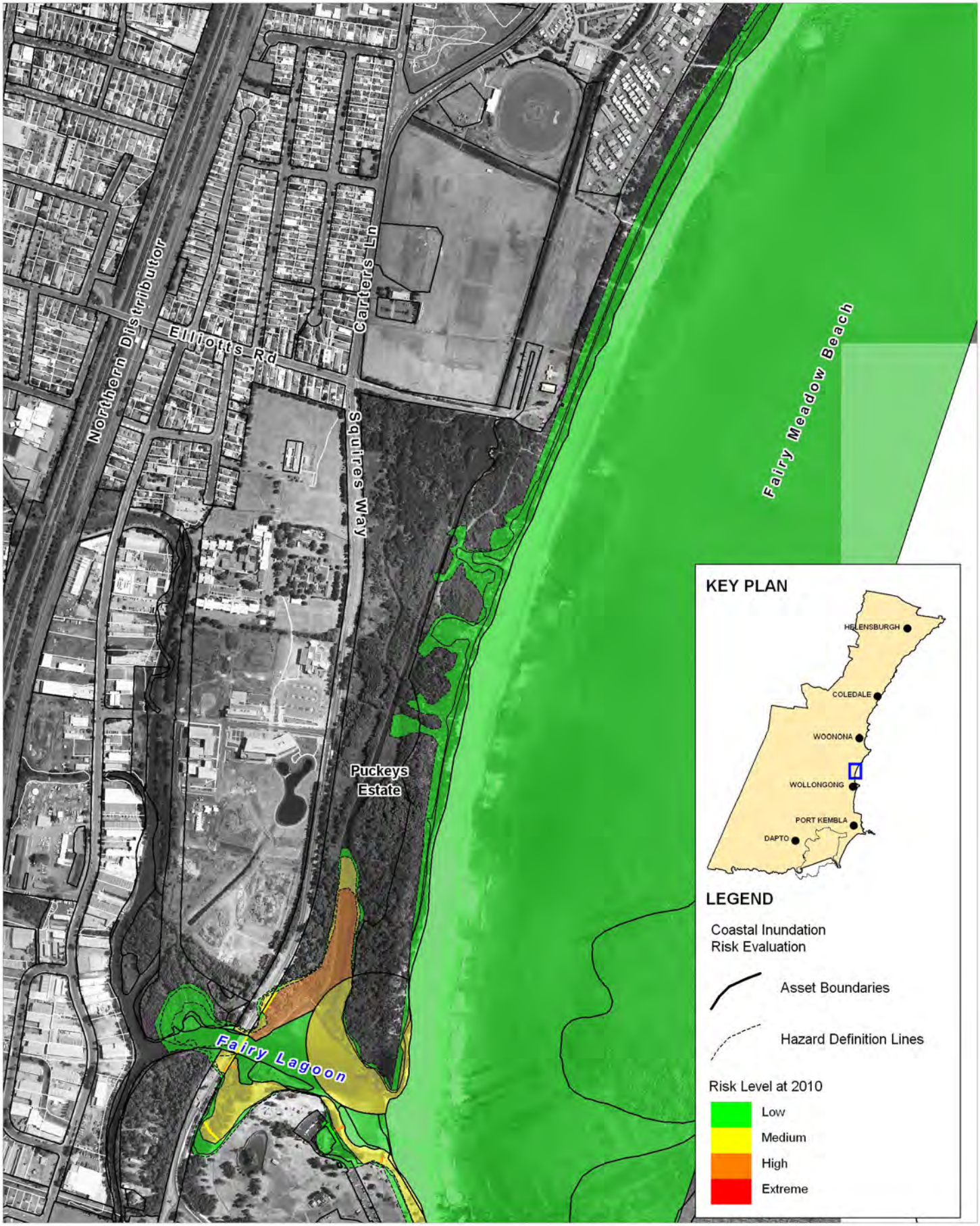
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_198_110419 Drawing D-8.WOR



Title:

Coastal Inundation Risk Evaluation
2010 Planning Horizon - Fairy Meadow

Drawing: D-9

Rev: A

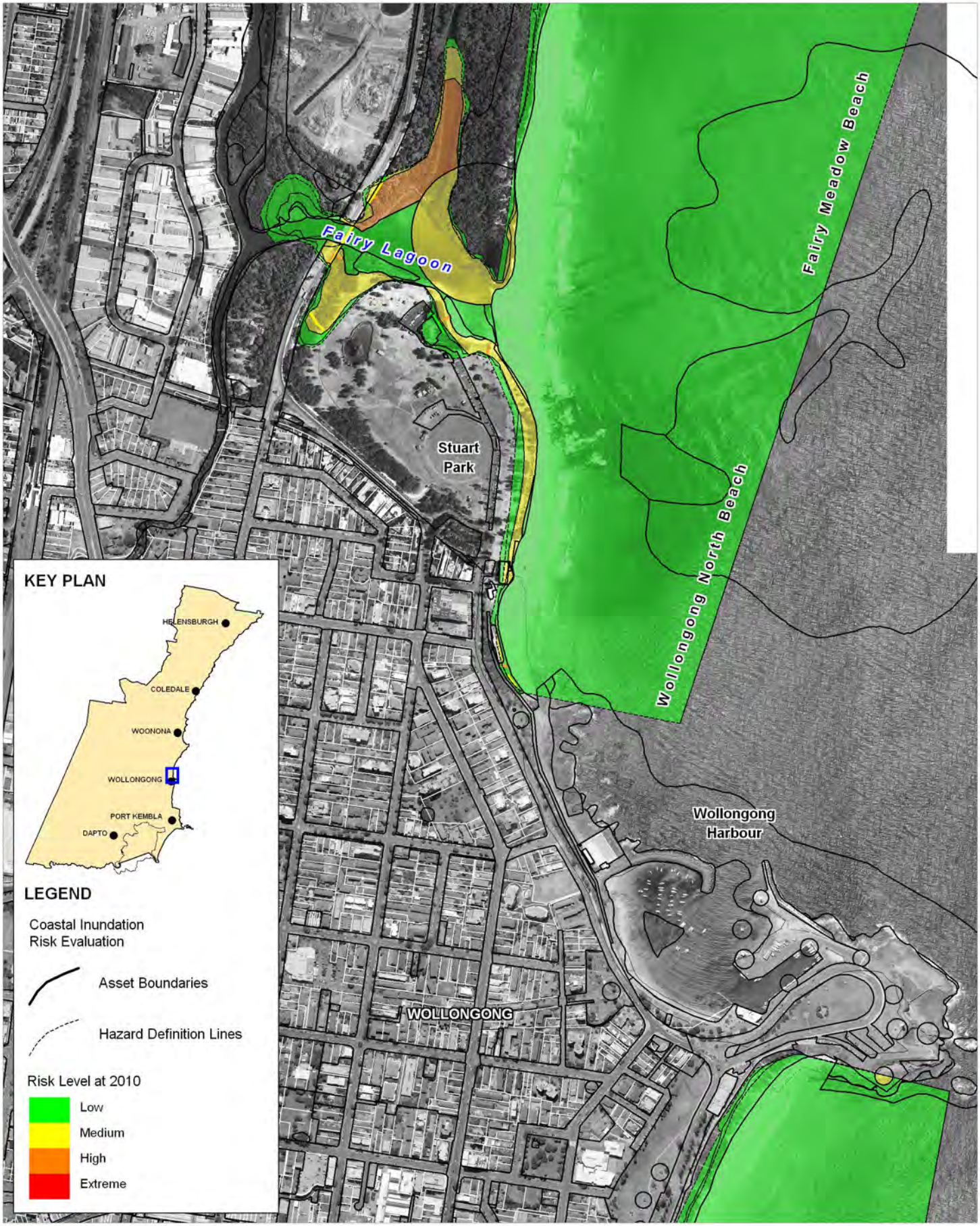
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_199_110419 Drawing D-9.WOR



Title:

Coastal Inundation Risk Evaluation 2010 Planning Horizon - Wollongong

Drawing: D-10

Rev: A

N

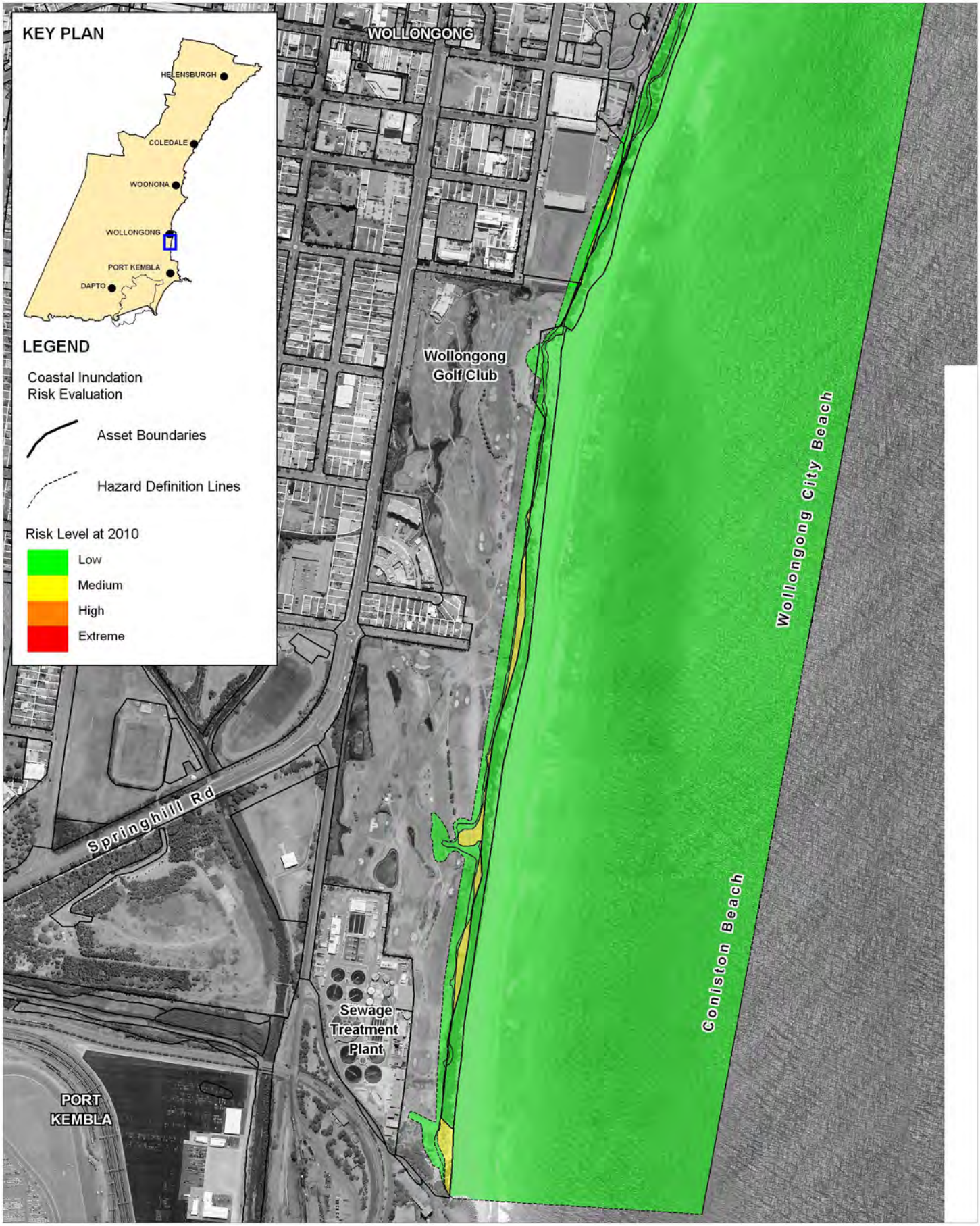
0 200 400m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_200_110419 Drawing D-10.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Wollongong City Beach

Drawing: D-11

Rev: A

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N

0 200 400m

Approx. Scale

BMT WBM
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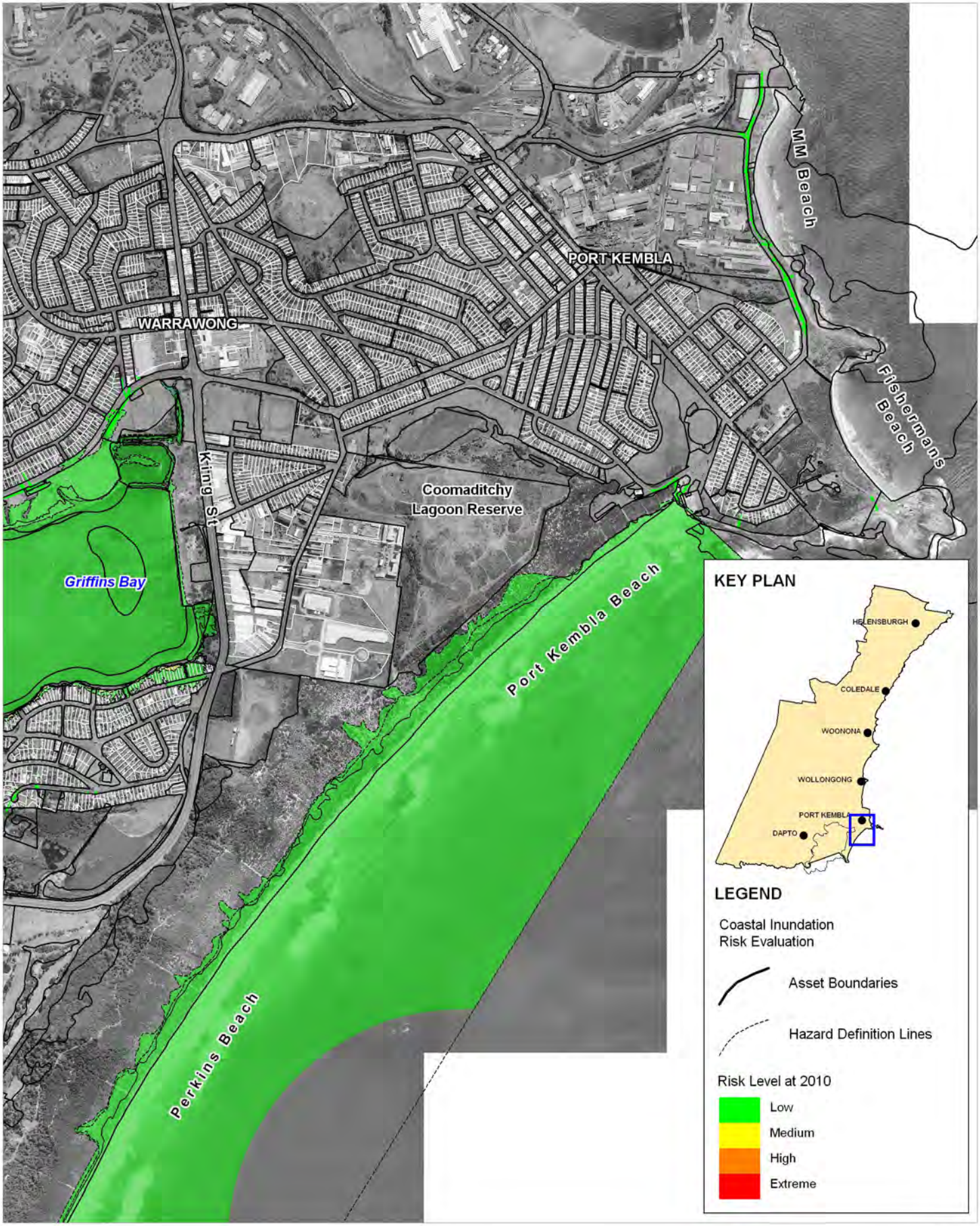
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_201_110419 Drawing D-11.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Port Kembla

Drawing: D-12

Rev: A

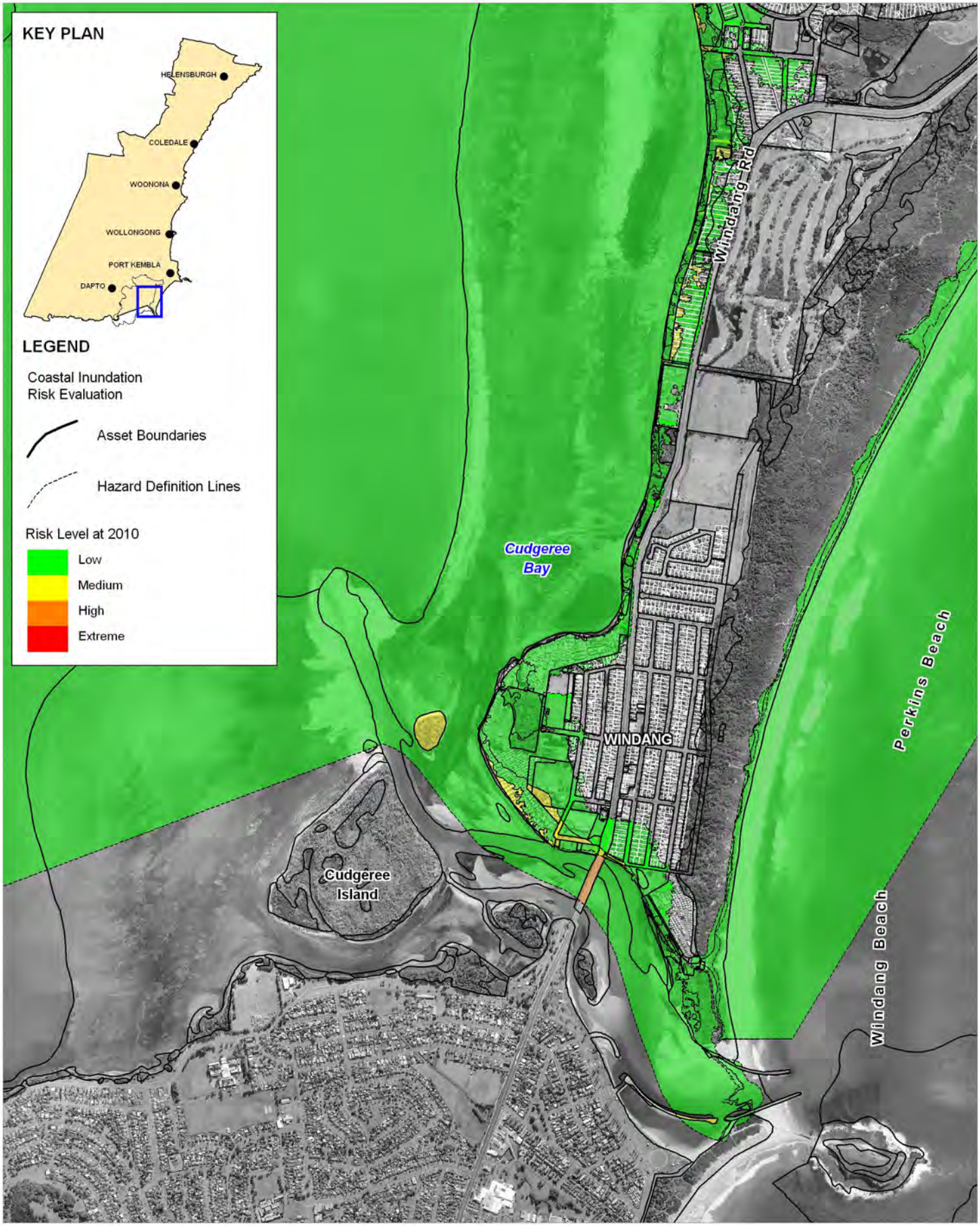
N

0 375 750m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_202_110419 Drawing D-12.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Windang

Drawing: D-13

Rev: A

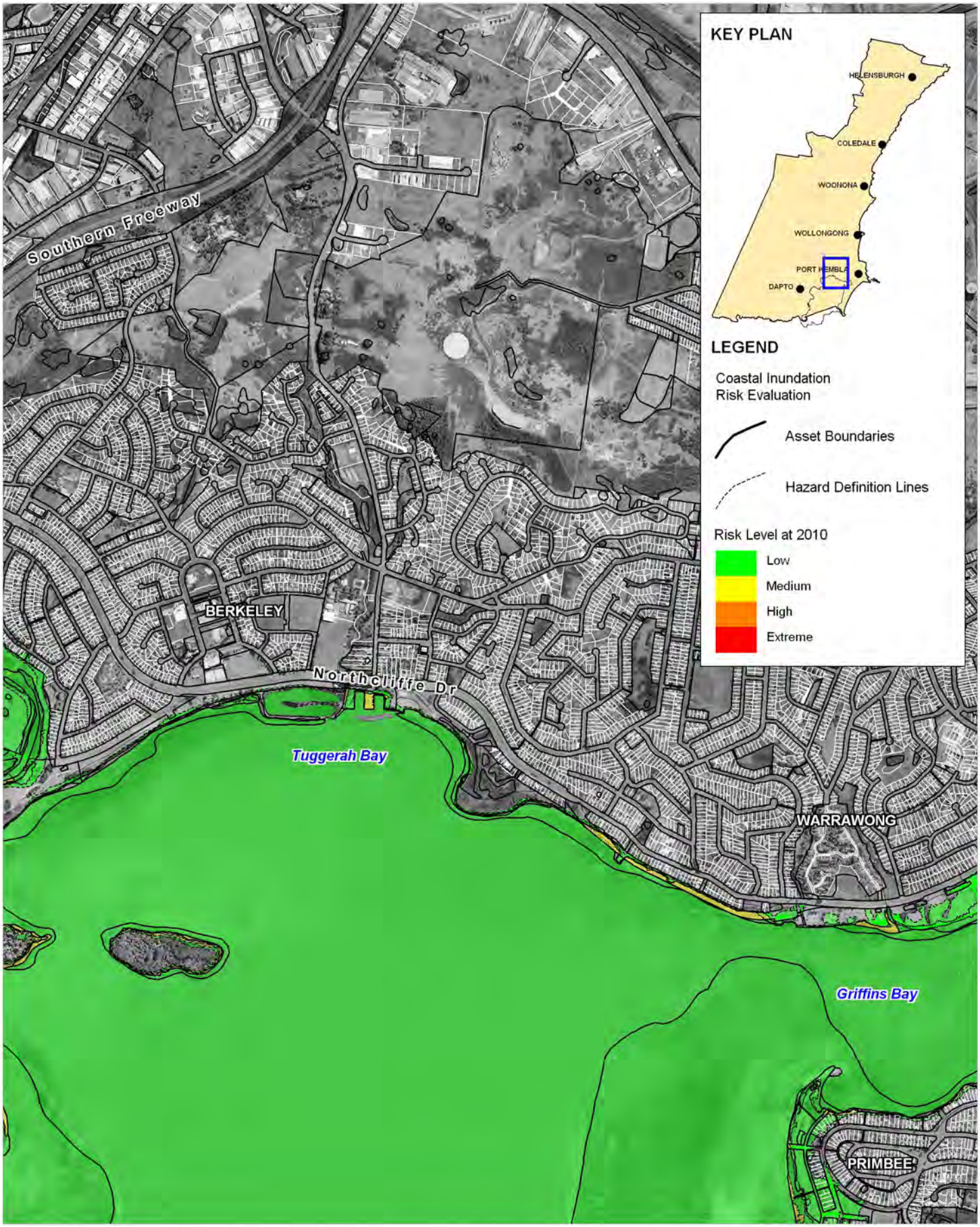
N

0 375 750m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_203_110419 Drawing D-13.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Berkeley/Warrawong

Drawing: D-14

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM

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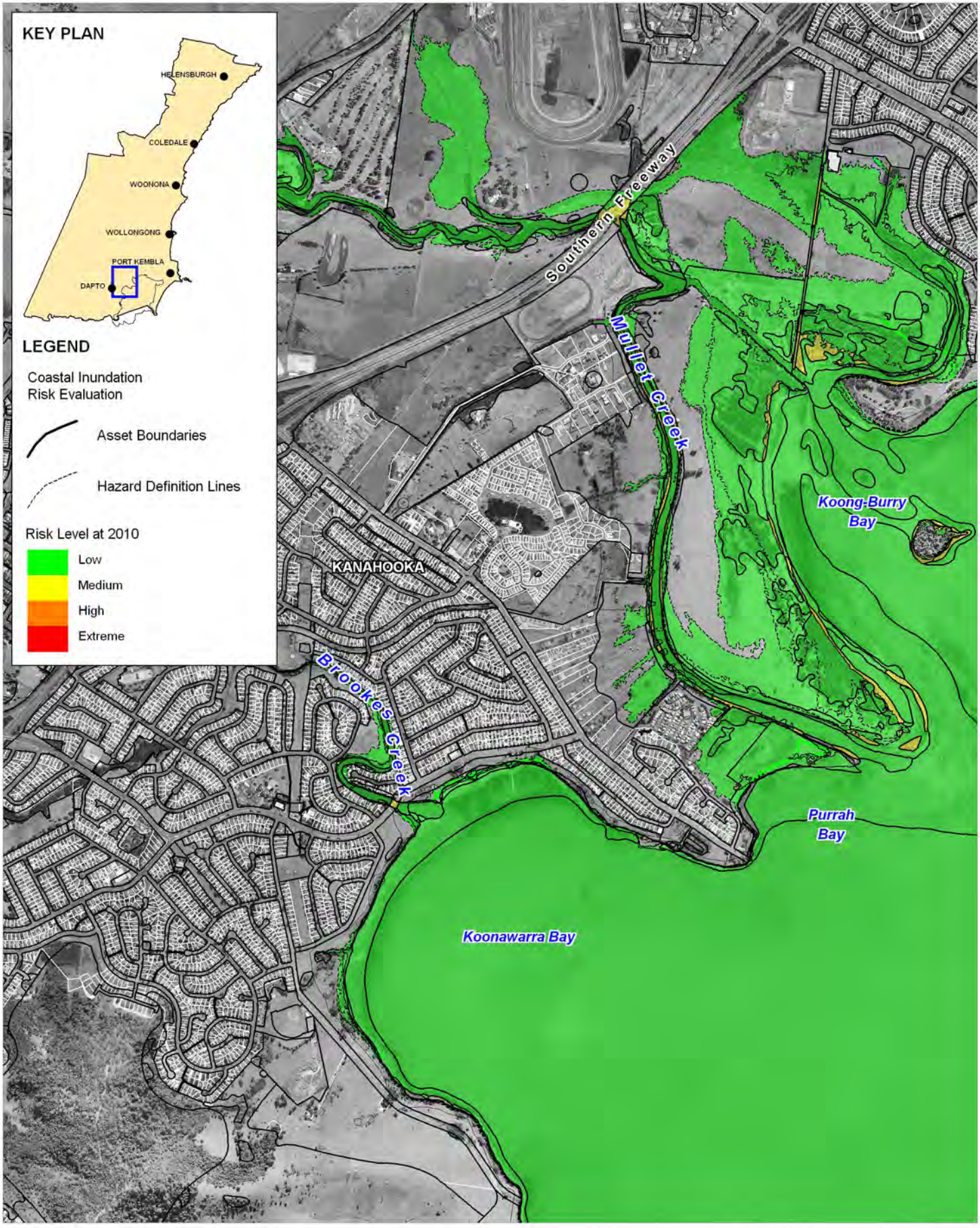
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_204_110420 Drawing D-14.WOR



Title:

Coastal Inundation Risk Evaluation
Immediate Planning Horizon - Kanahooka

Drawing: D-15

Rev: A

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N

0 375 750m

Approx. Scale

BMT WBM
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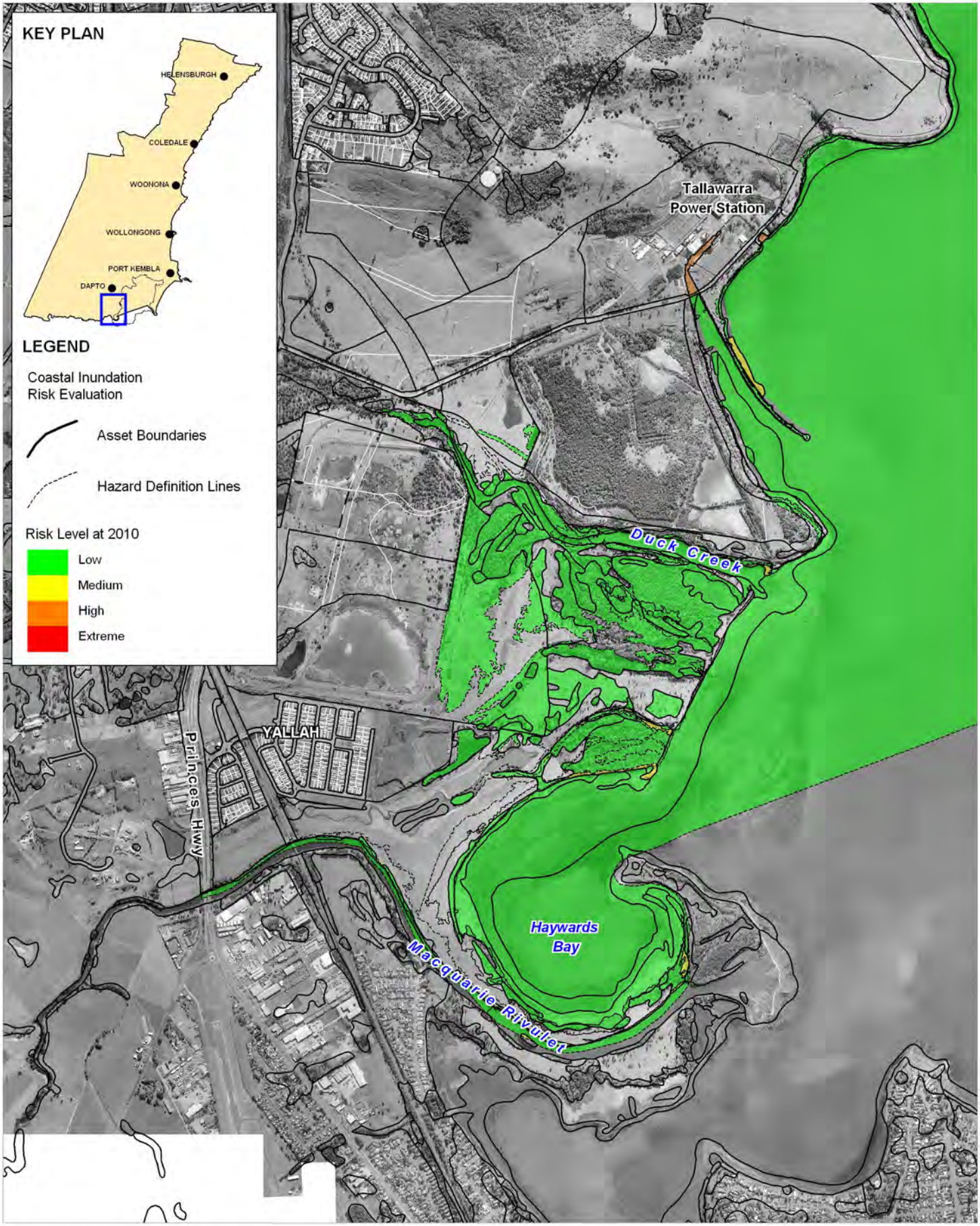
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_205_110420 Drawing D-15.WOR



Title:

Coastal Inundation Risk Evaluation immediate Planning Horizon - Tellawarra

Drawing: D-16

Rev: A

N

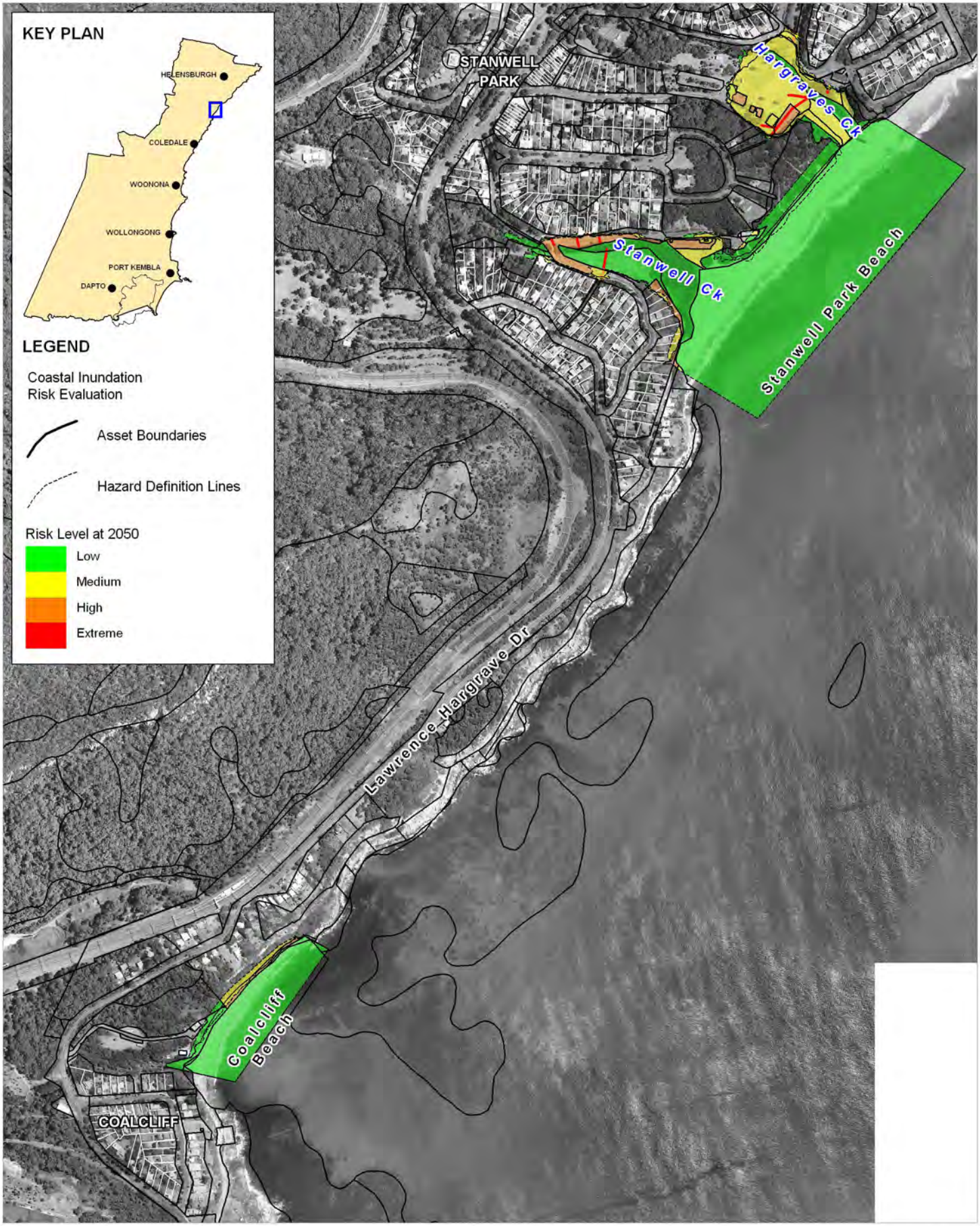
0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_206_110420 Drawing D-16.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Stanwell Park / Coalcliff

Drawing: E-1

Rev: A

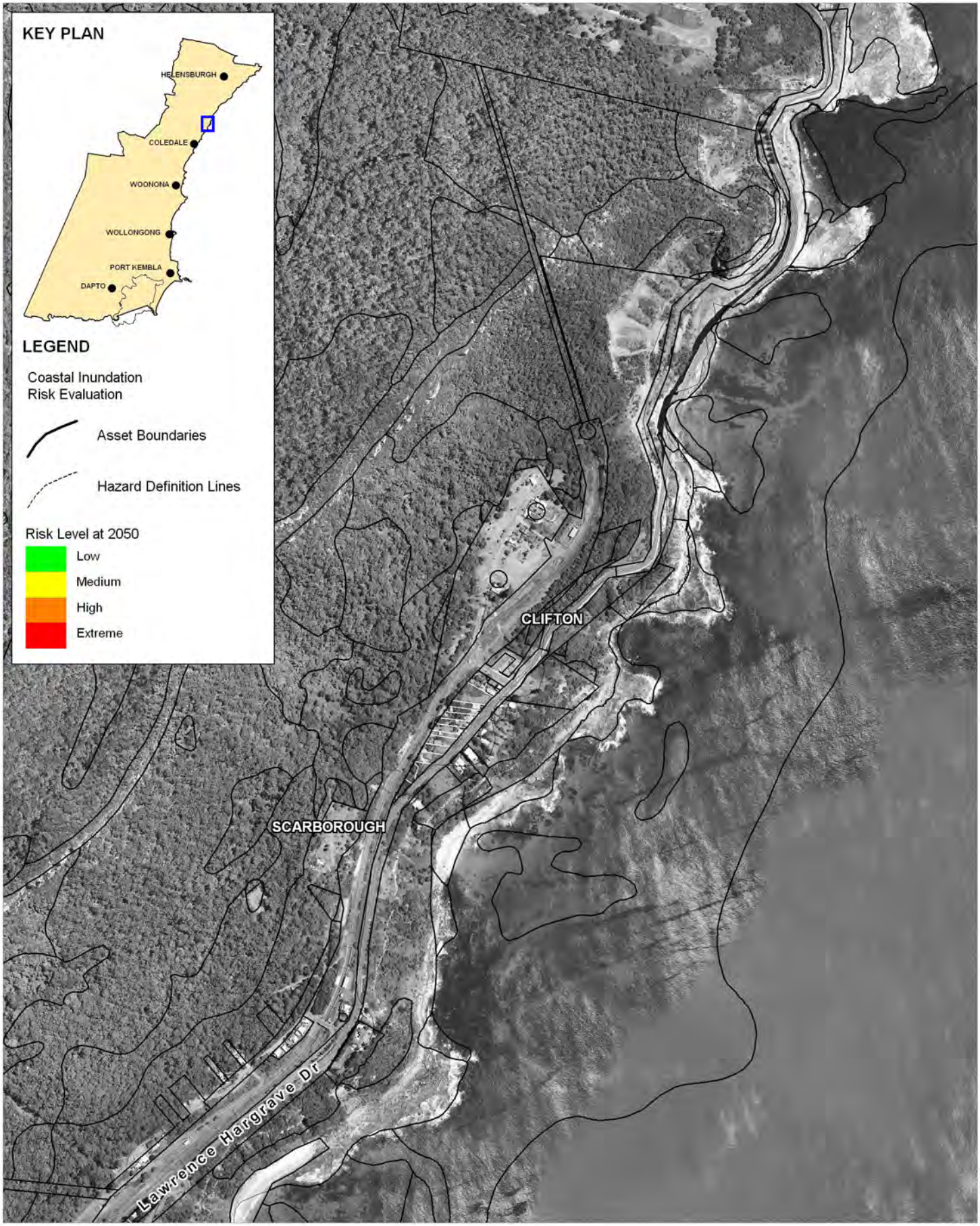
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_207_110419 Drawing E-1.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Clifton / Scarborough

Drawing: E-2

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 200 400m

Approx. Scale

BMT WBM
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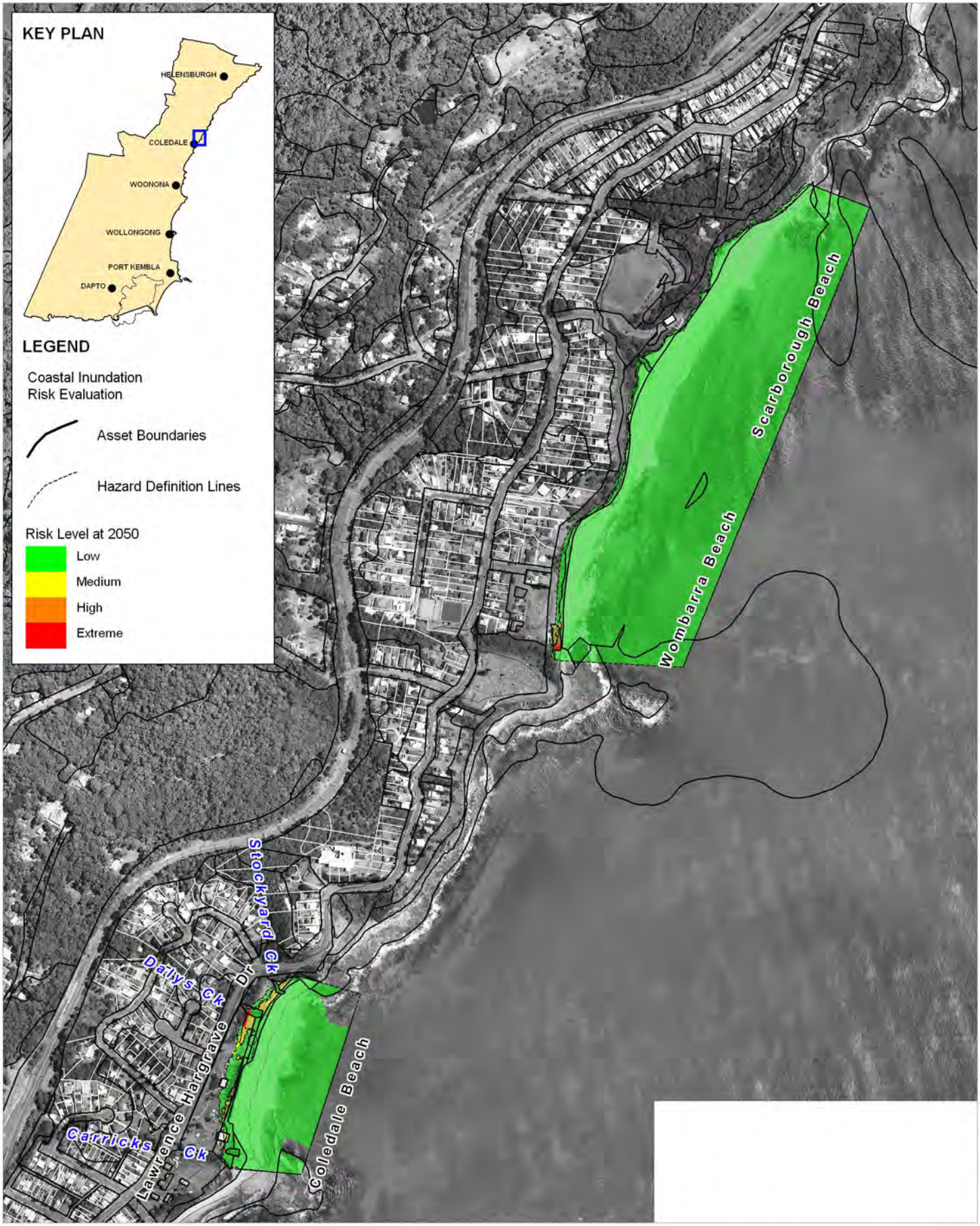
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_208_110419 Drawing E-2.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Scarborough/Coledale

Drawing: E-3

Rev: A

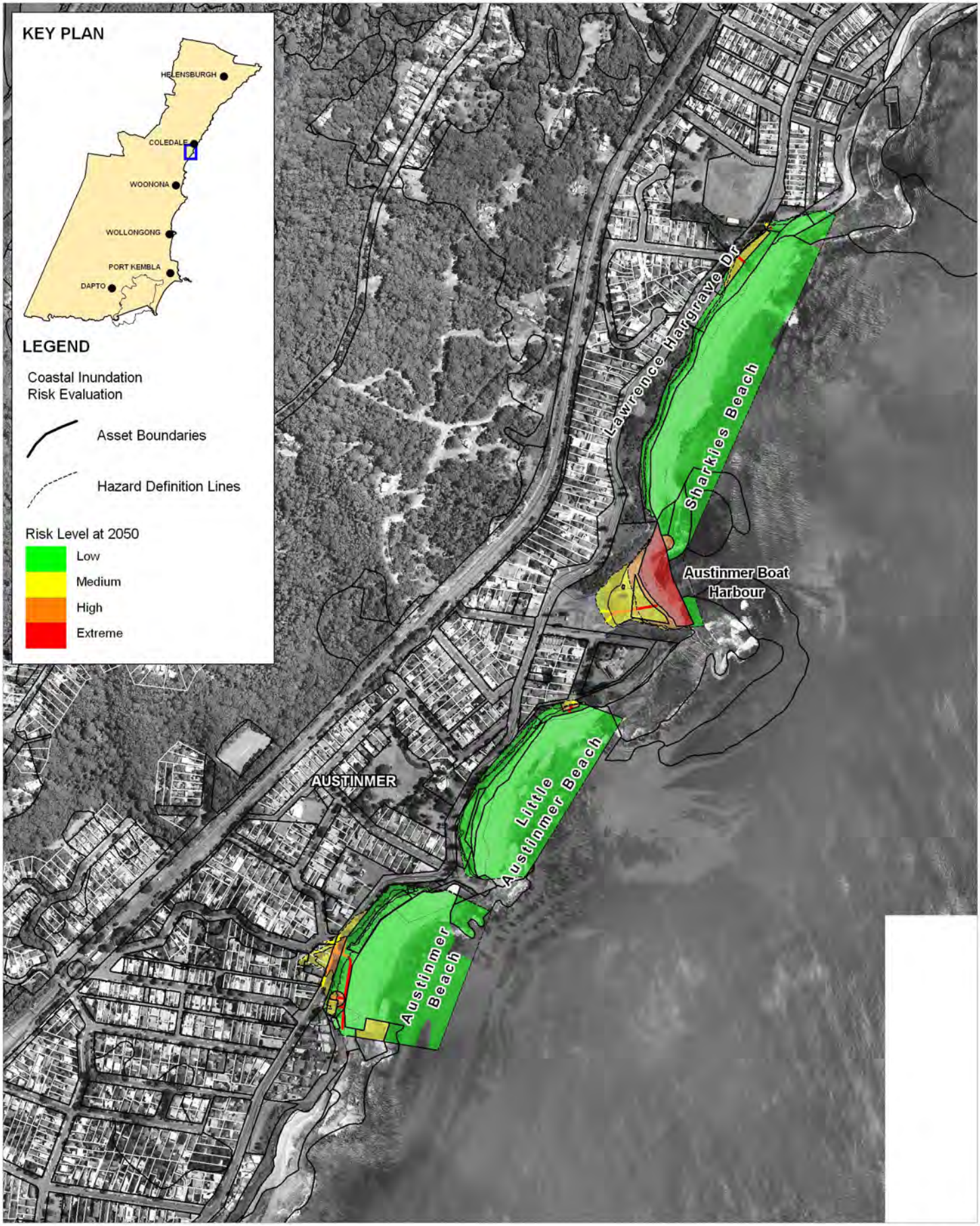
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_209_110419 Drawing E-3.WOR



Title:

Coastal Inundation Risk Evaluation 2050 Planning Horizon - Austinmer

Drawing: E-4

Rev: A

N

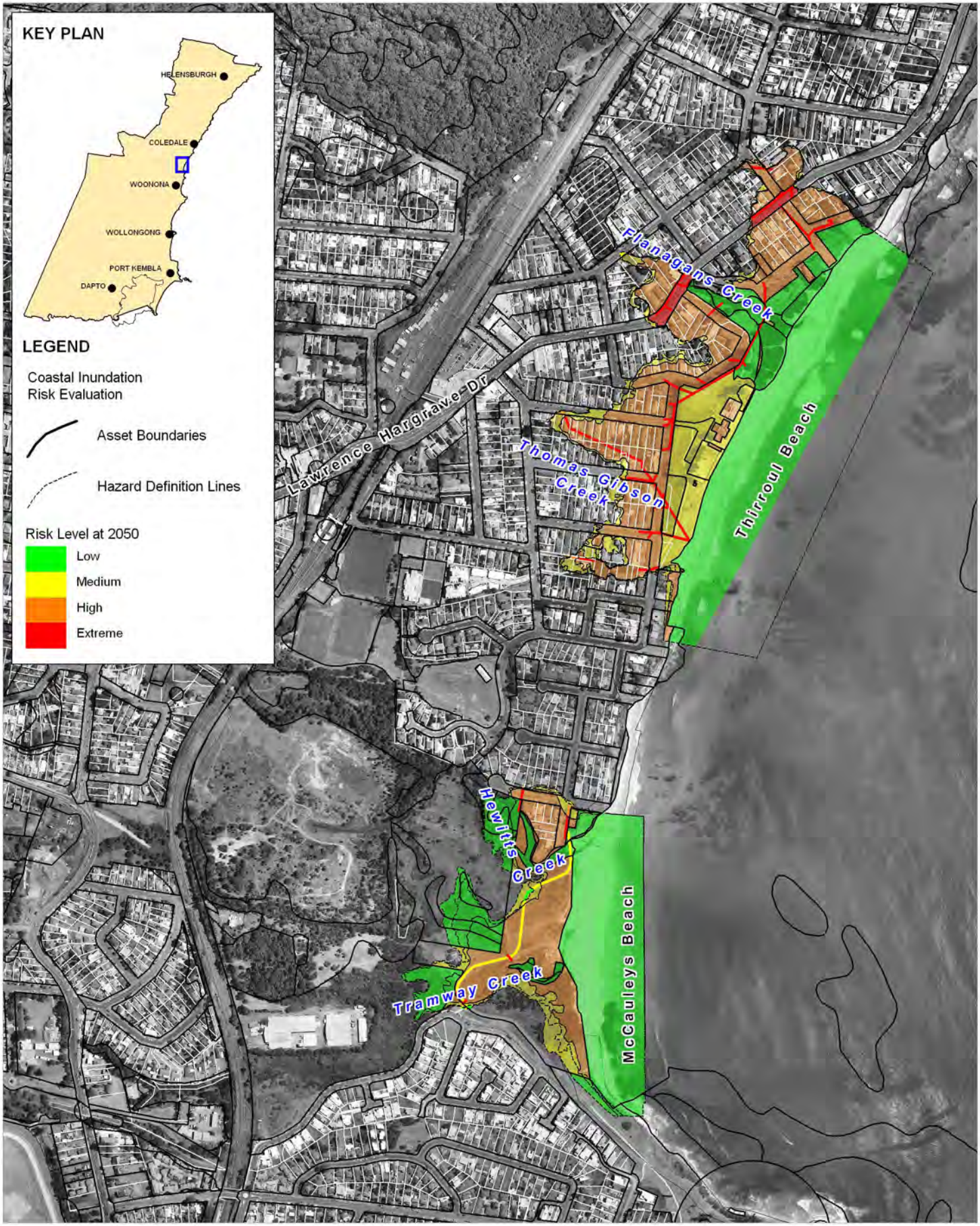
0 200 400m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_210_110419 Drawing E-4.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Thirroul/McCauleys

Drawing: E-5

Rev: A

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N

0 200 400m

Approx. Scale

BMT WBM
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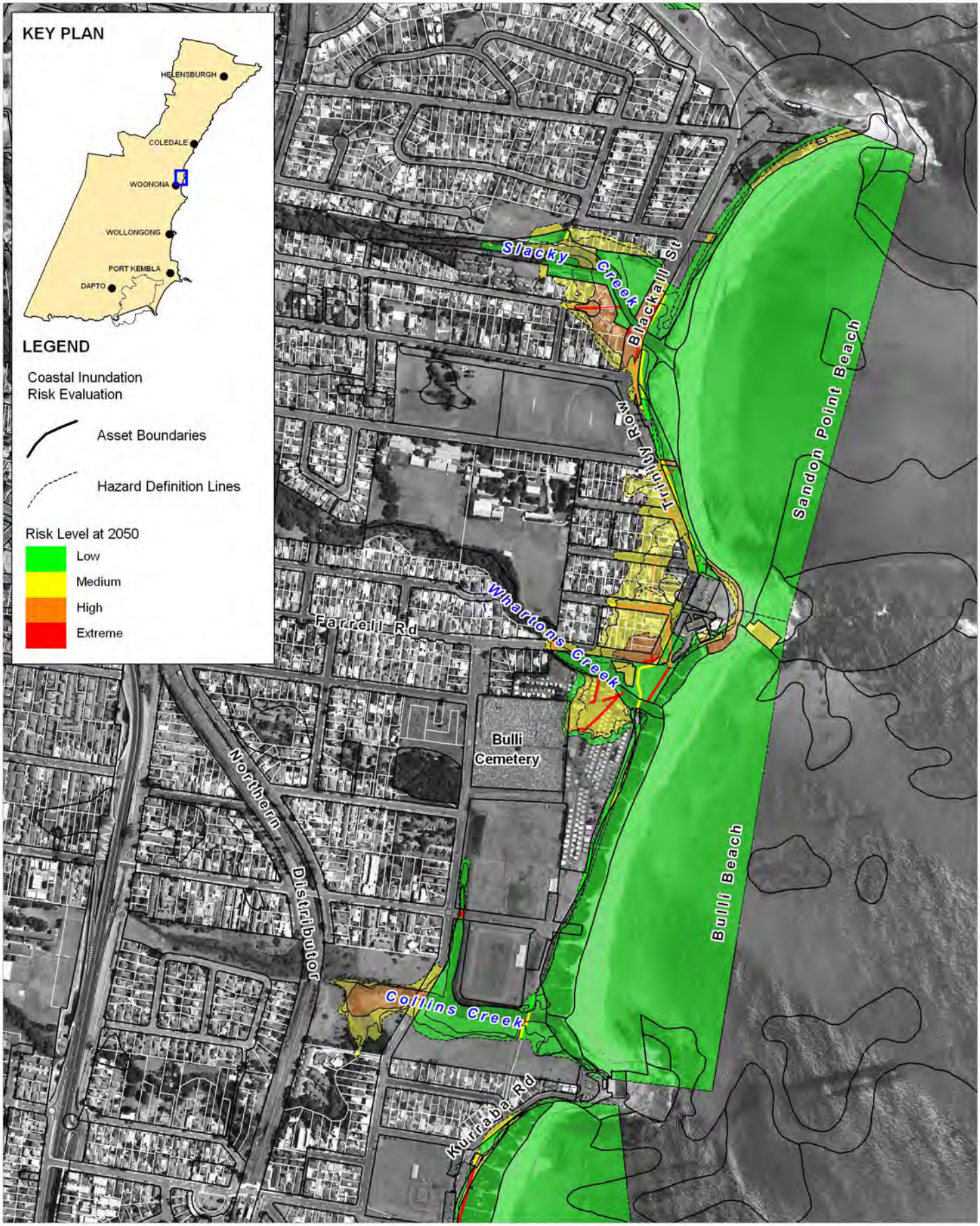
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_211_110419 Drawing E-5.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Sandon/Bulli

Drawing: E-6

Rev: A

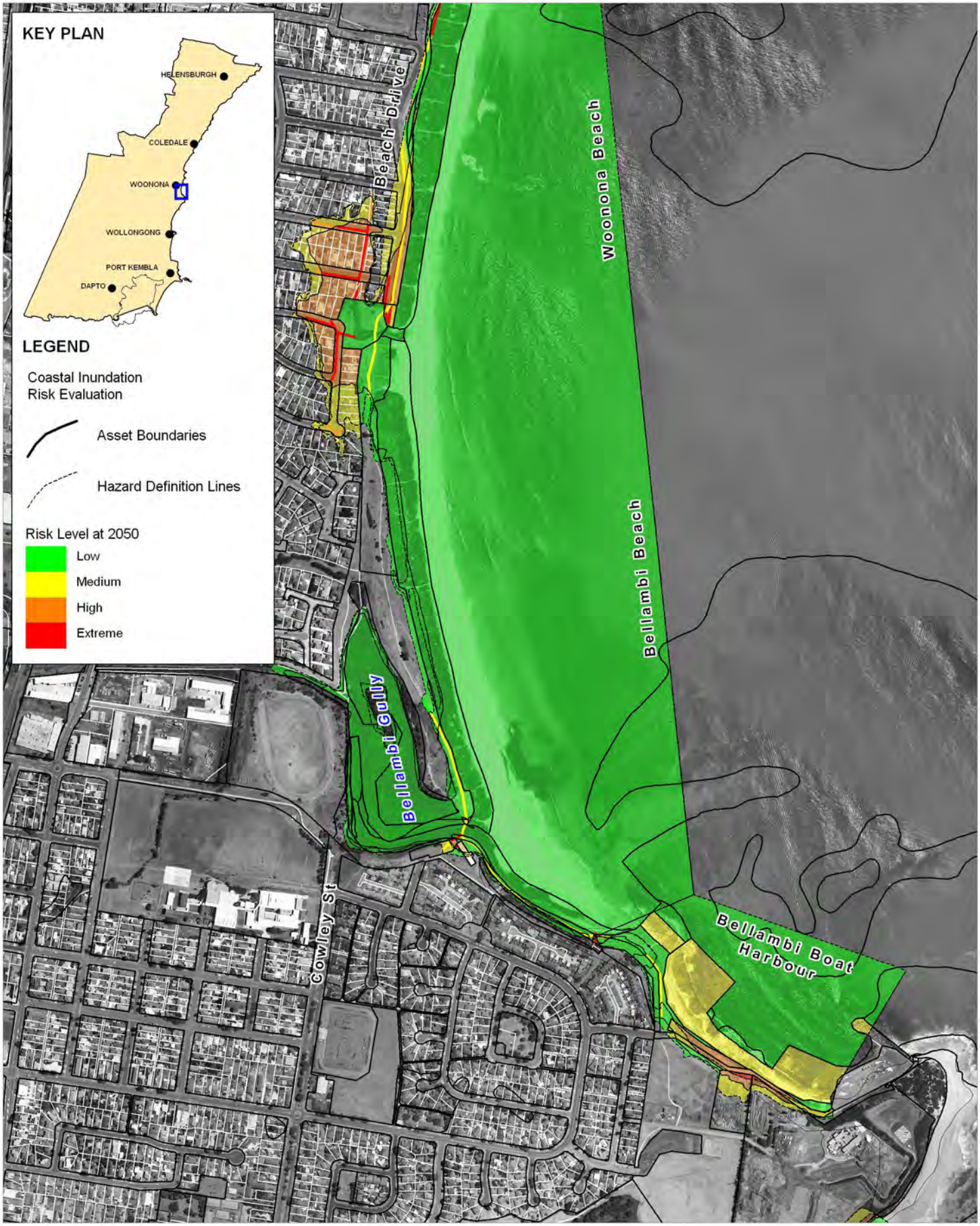
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_212_110419 Drawing E-6.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Woonona/Bellambi

Drawing: E-7

Rev: A

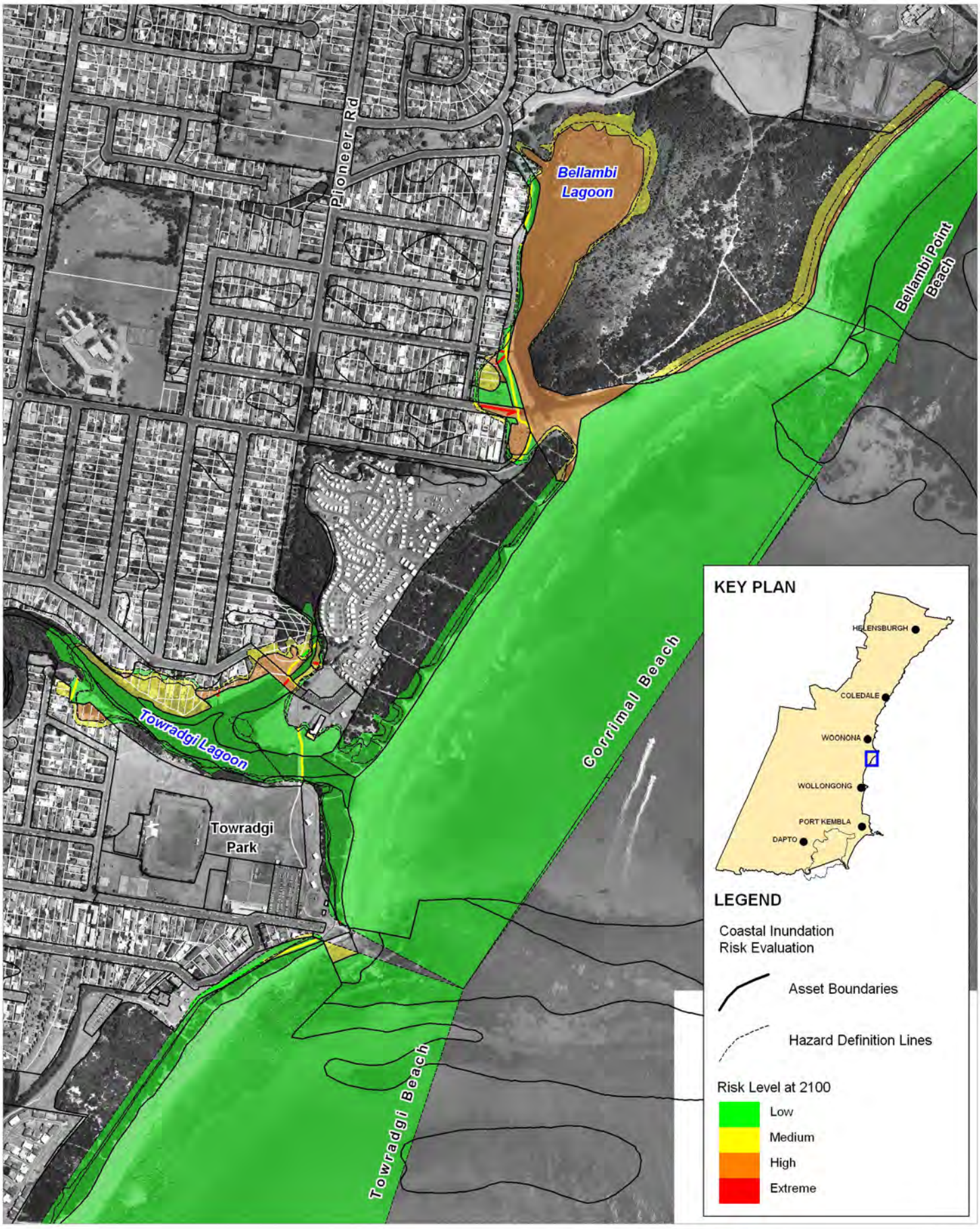
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_213_110419 Drawing E-7.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Corrimal Beach

Drawing: E-8

Rev: A

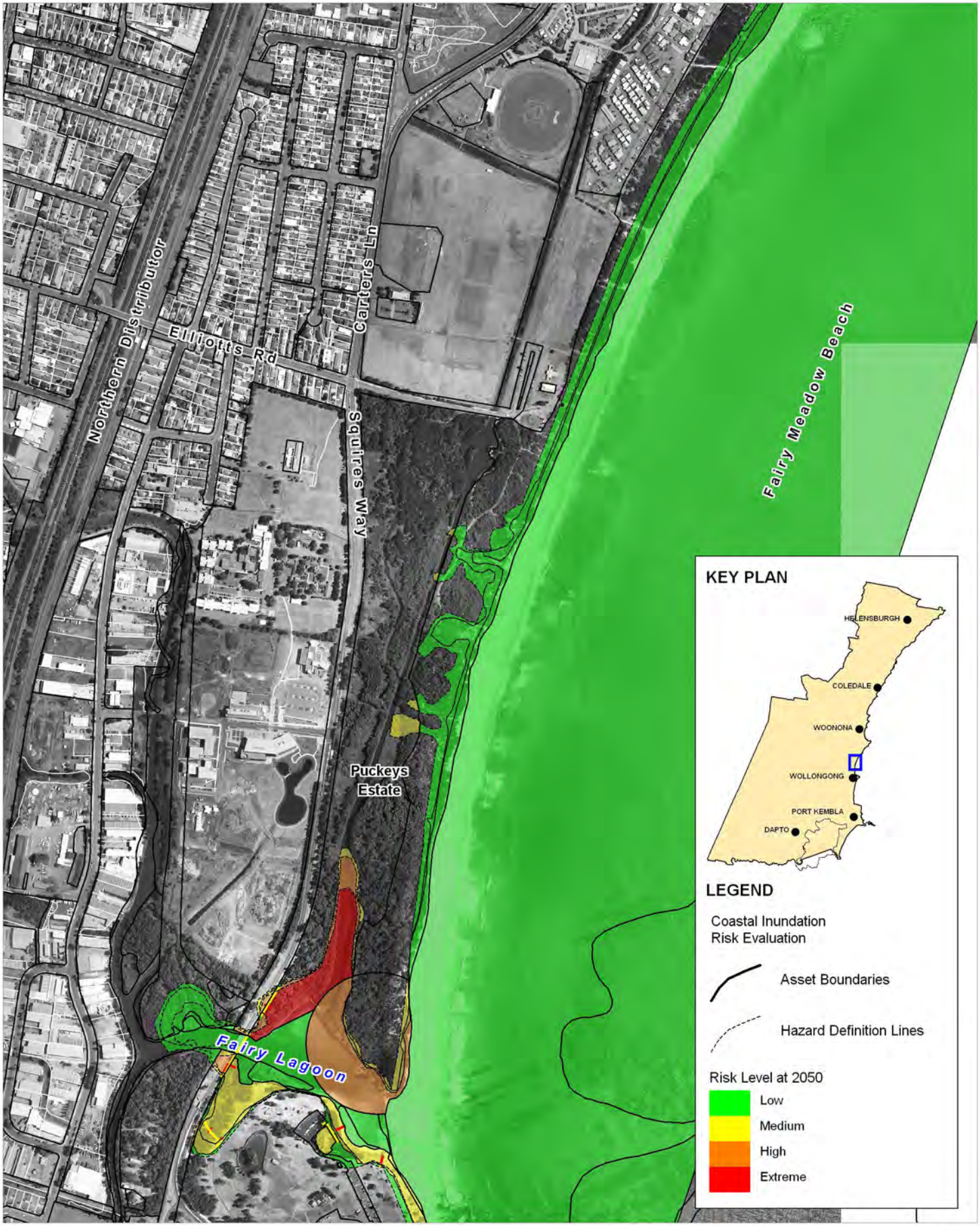
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_214_110419 Drawing E-8.WOR



Title:

Coastal Inundation Risk Evaluation 2050 Planning Horizon - Fairy Meadow

Drawing: E-9

Rev: A

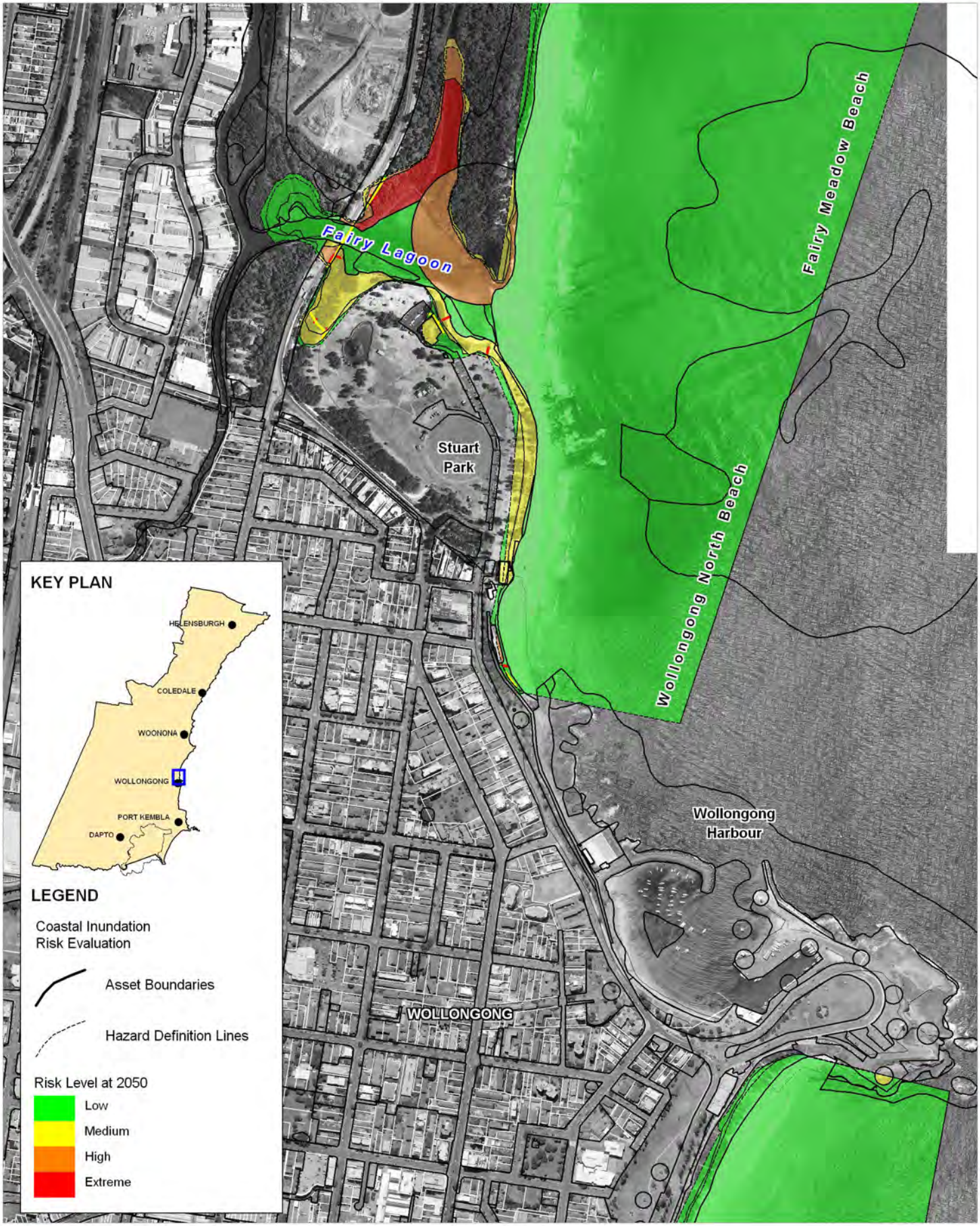
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_215_110419 Drawing E-9.WOR



Title:

Coastal Inundation Risk Evaluation 2050 Planning Horizon - Wollongong

Drawing: E-10

Rev: A

N

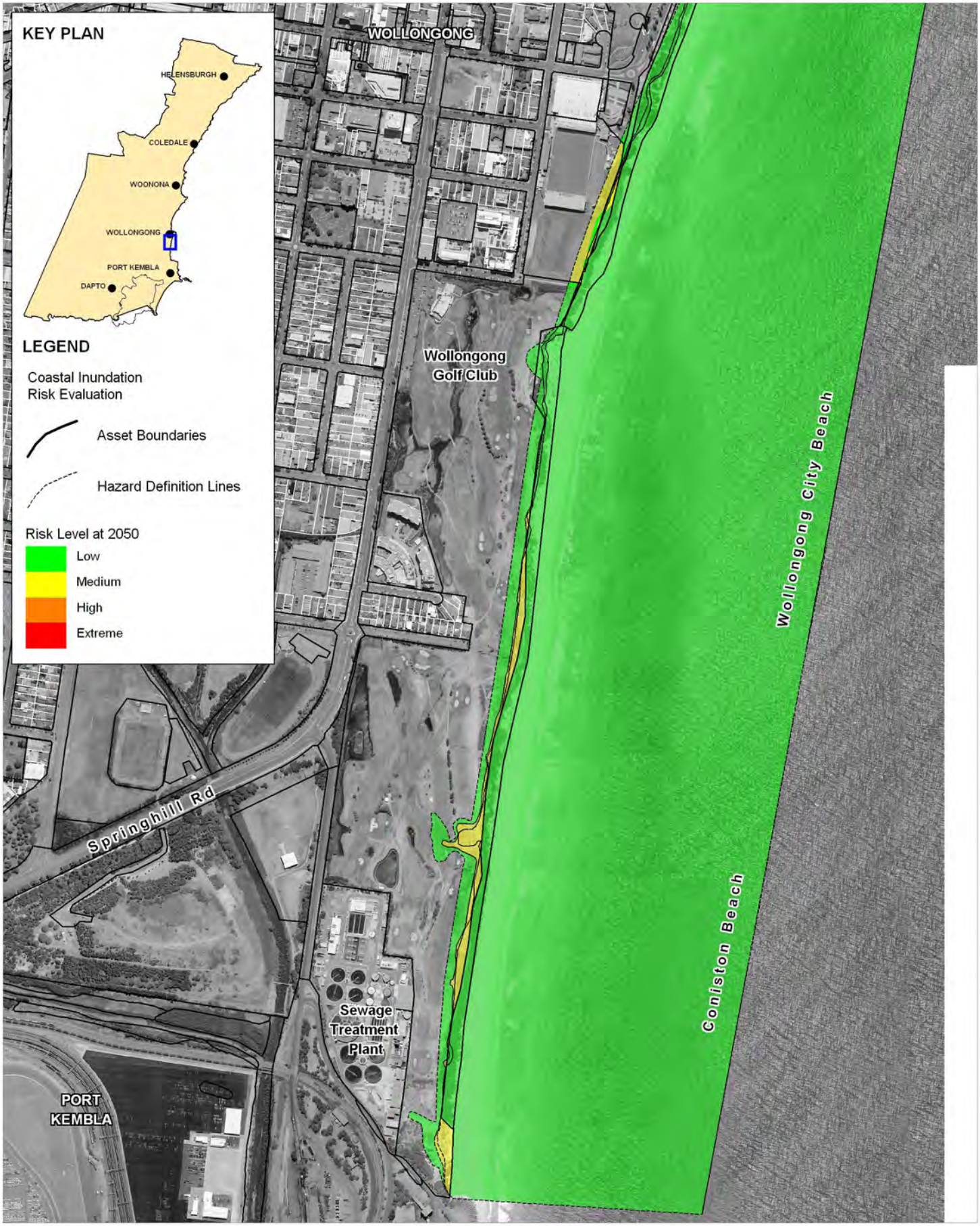
0 200 400m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_216_110419 Drawing E-10.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Wollongong City Beach

Drawing: E-11

Rev: A

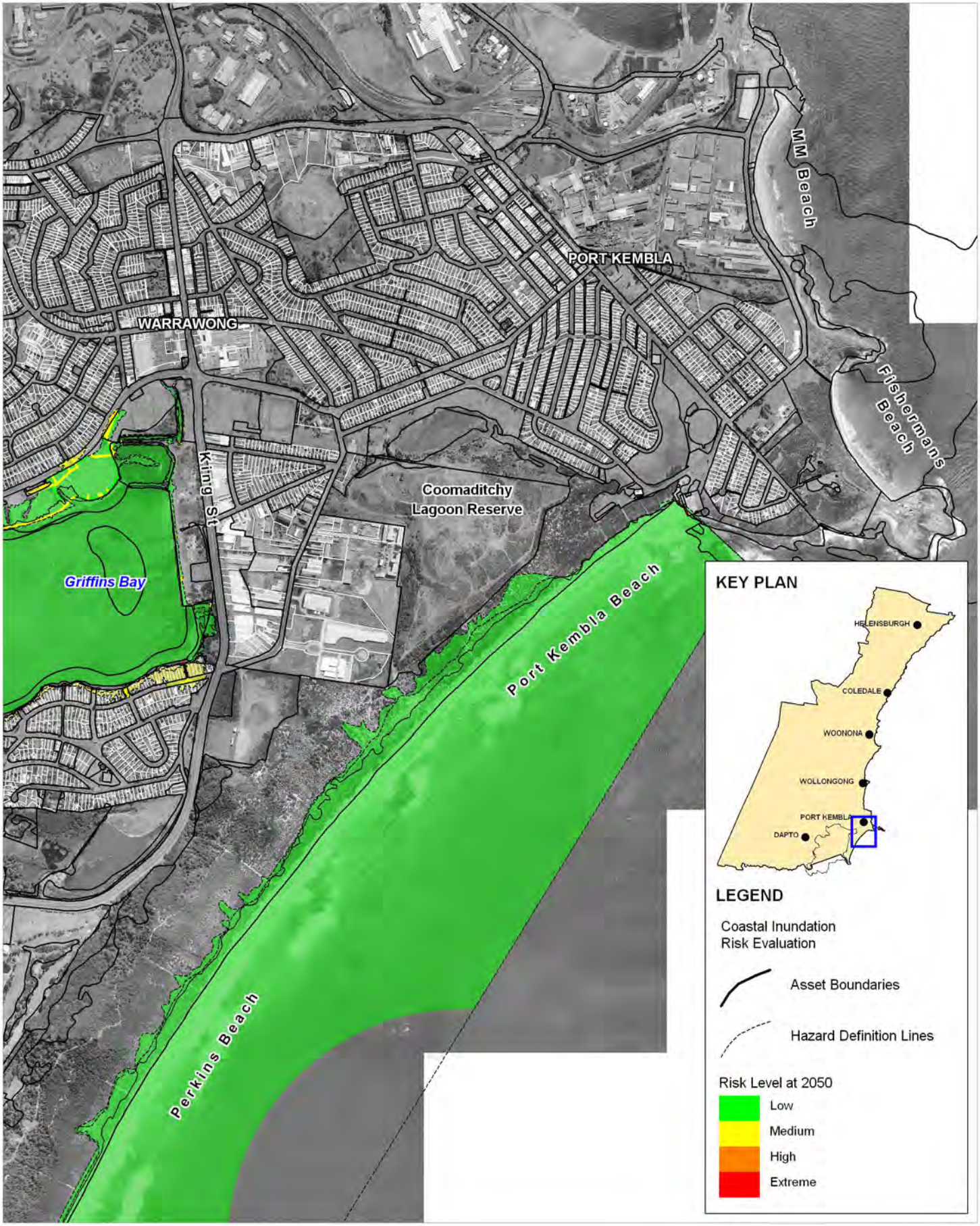
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_217_110419 Drawing E-11.WOR



Title:

Coastal Inundation Risk Evaluation 2050 Planning Horizon - Port Kembla

Drawing: E-12

Rev: A

N

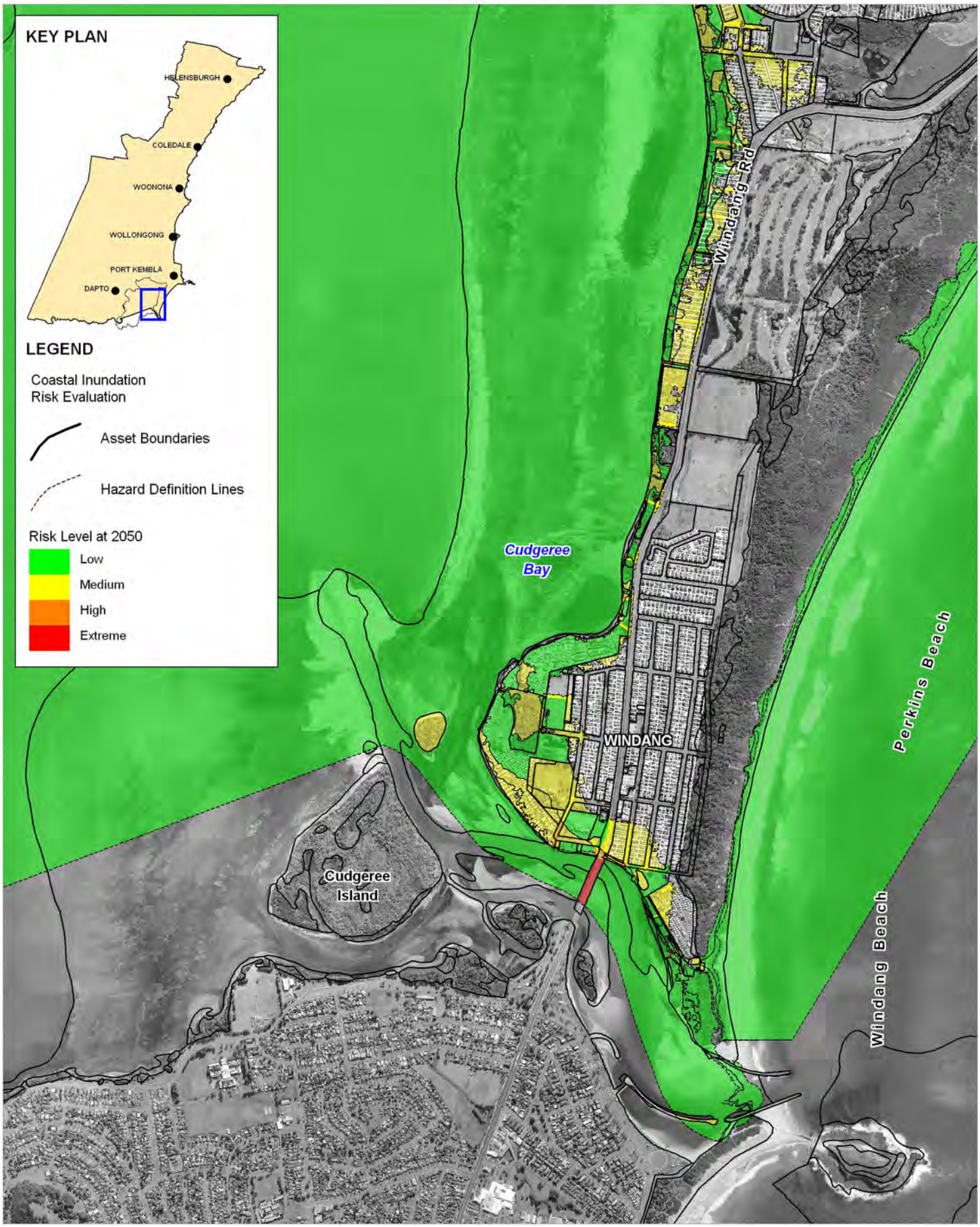
0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_218_110419 Drawing E-12.WOR



Title:

Coastal Inundation Risk Evaluation 2050 Planning Horizon - Windang

Drawing: E-13

Rev: A

N

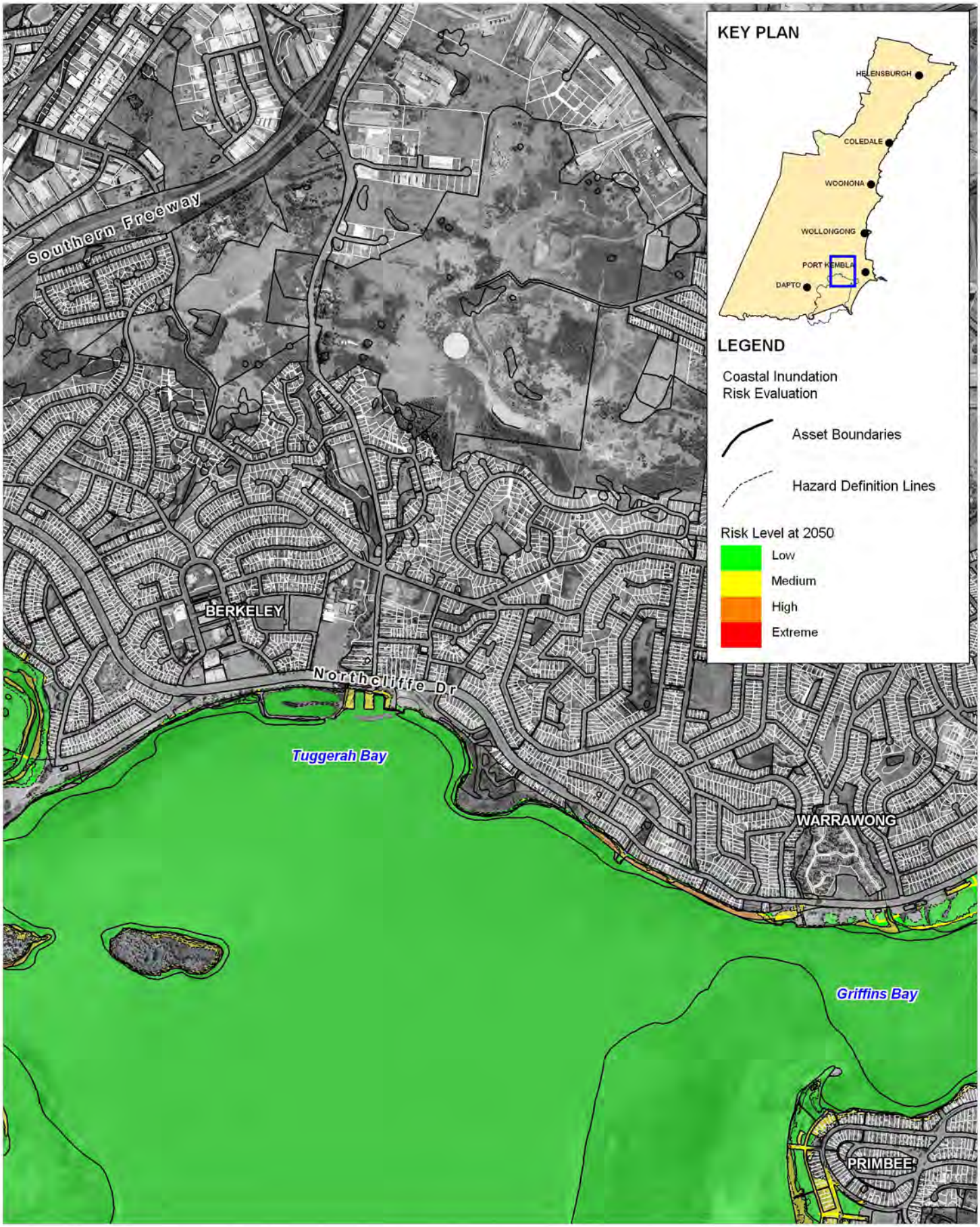
0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_219_110419 Drawing E-13.WOR



Title:

Coastal Inundation Risk Evaluation
2050 Planning Horizon - Berkeley/Warrawong

Drawing: E-14

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM

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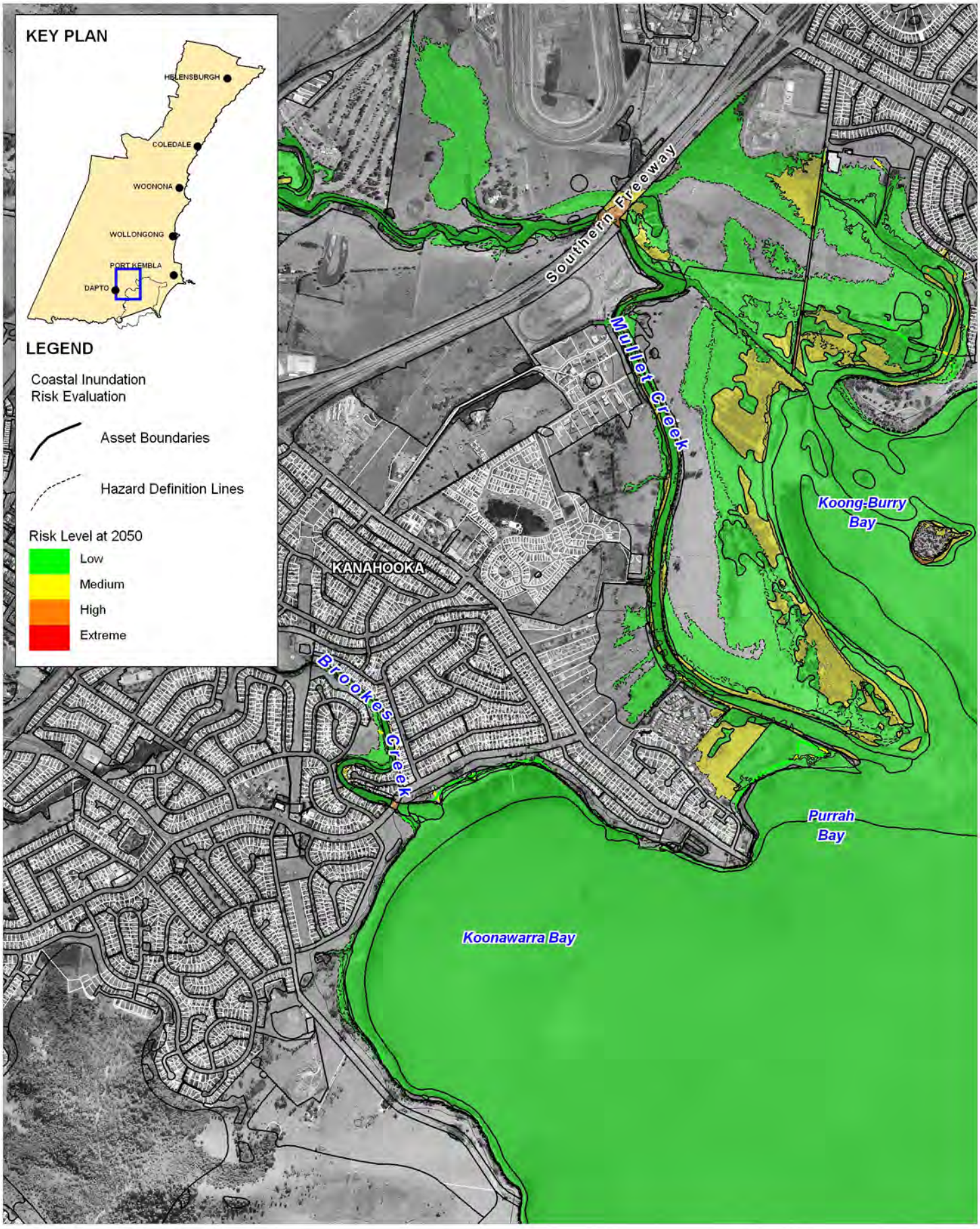
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_220_110419 Drawing E-14.WOR



Title:

Coastal Inundation Risk Evaluation 2050 Planning Horizon - Kanahooka

Drawing: E-15

Rev: A

N

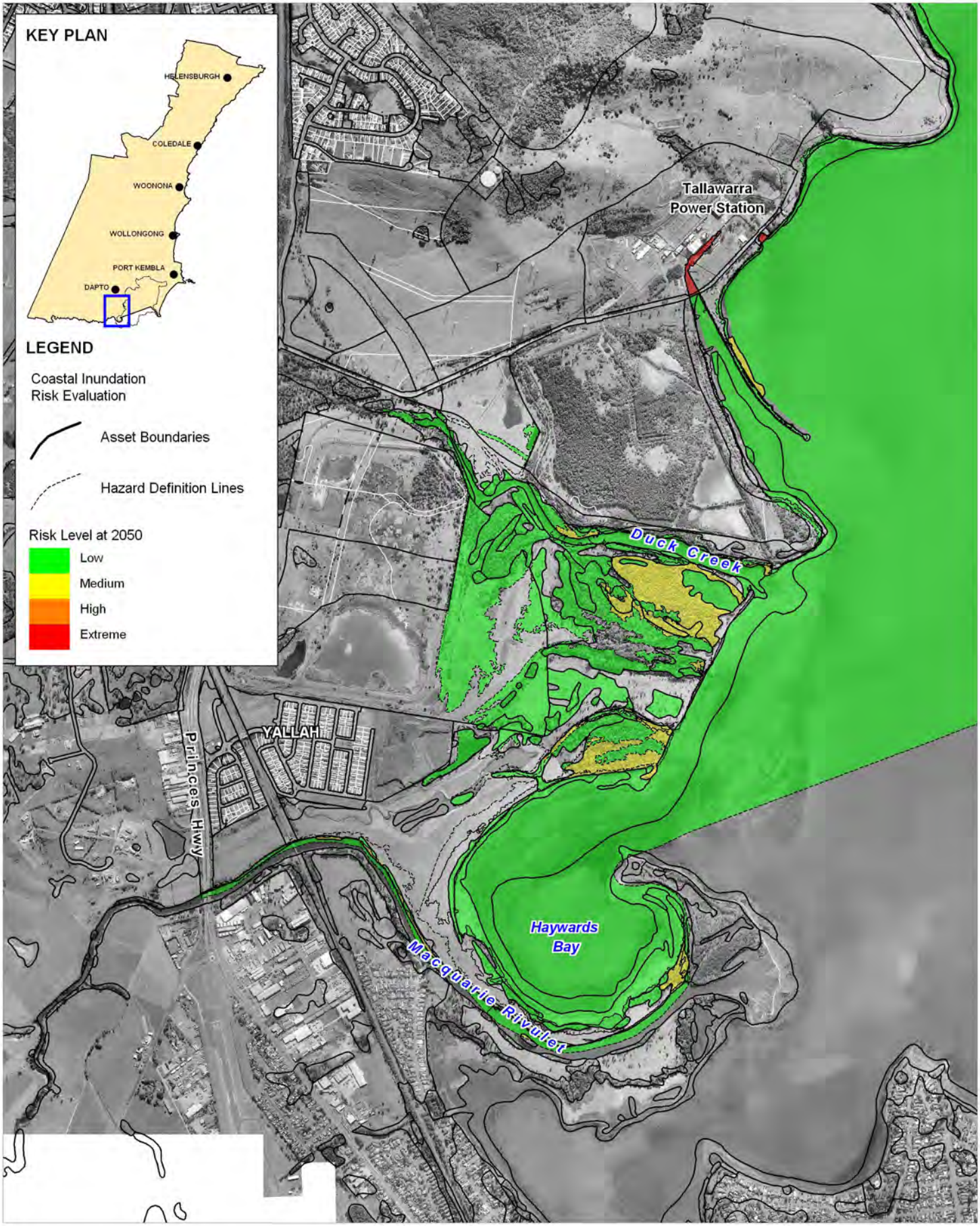
0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_221_110420 Drawing E-15.WOR



Title:

Coastal Inundation Risk Evaluation 2050 Planning Horizon - Tallawarra

Drawing: E-16

Rev: A

N

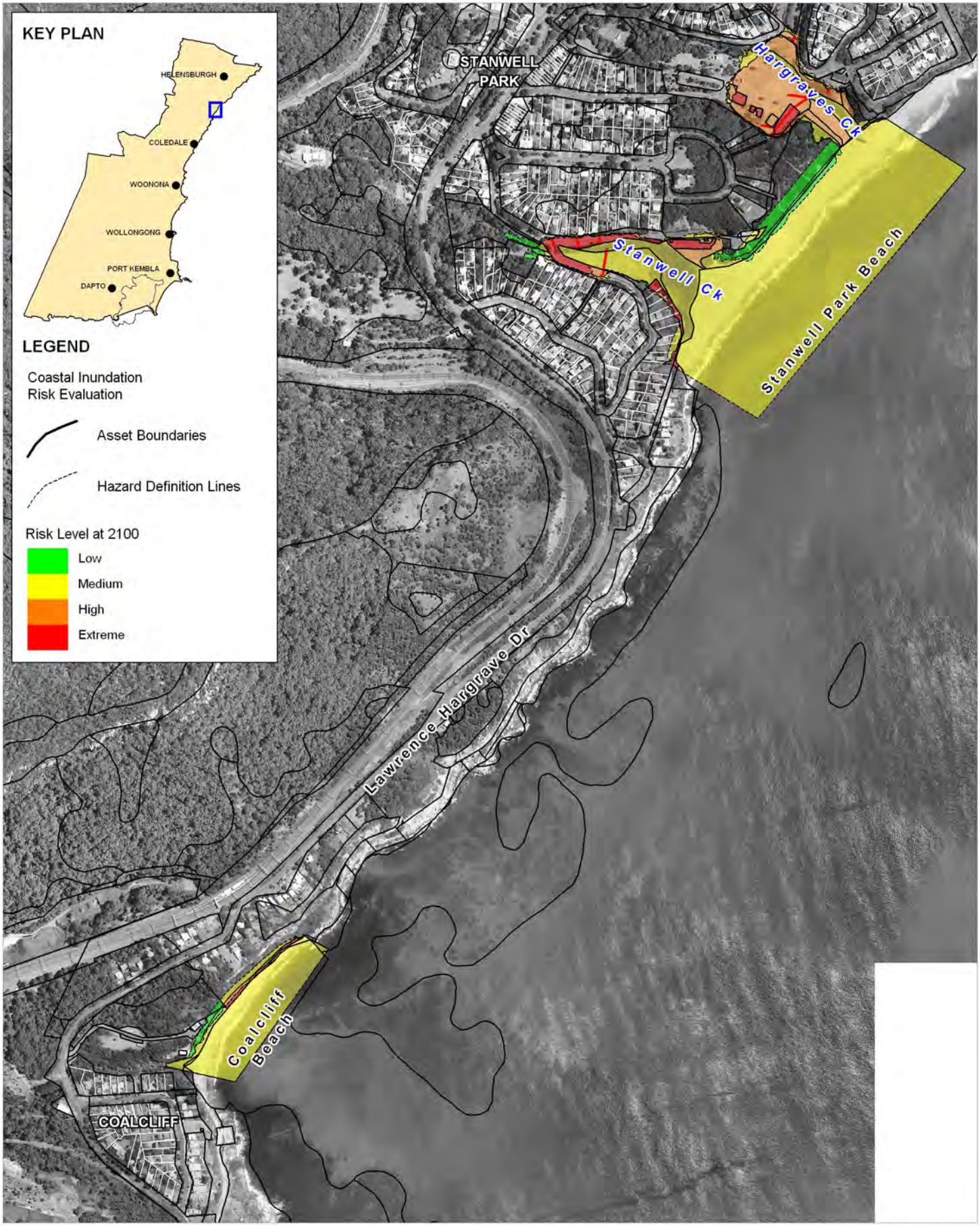
0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_222_110420 Drawing E-16.WOR



Title:

Coastal Inundation Risk Evaluation
2100 Planning Horizon - Stanwell Park / Coalcliff

Drawing: F-1

Rev: A

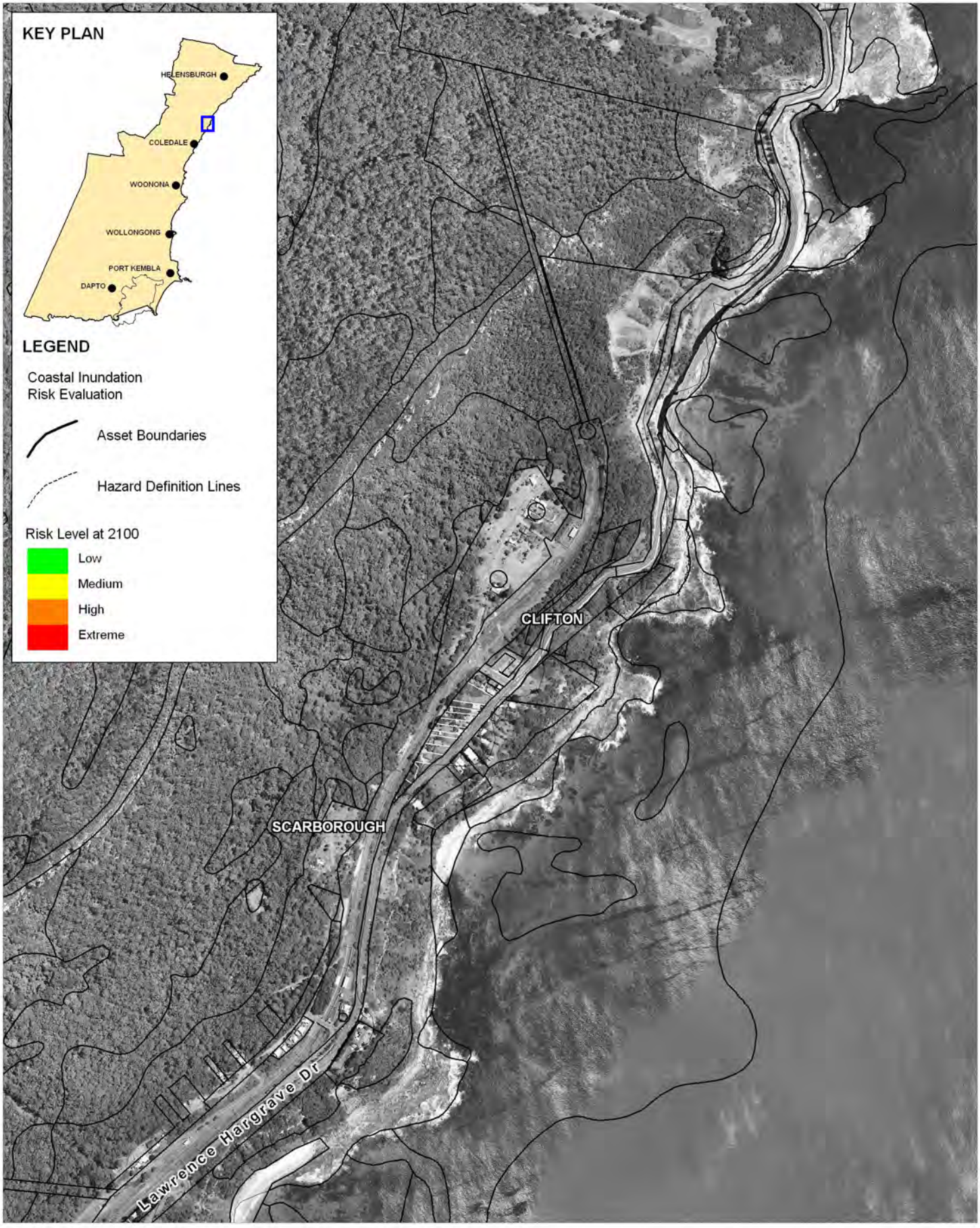
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_223_110419 Drawing F-1.WOR



Title:

Coastal Inundation Risk Evaluation
2100 Planning Horizon - Clifton / Scarborough

Drawing: F-2

Rev: A

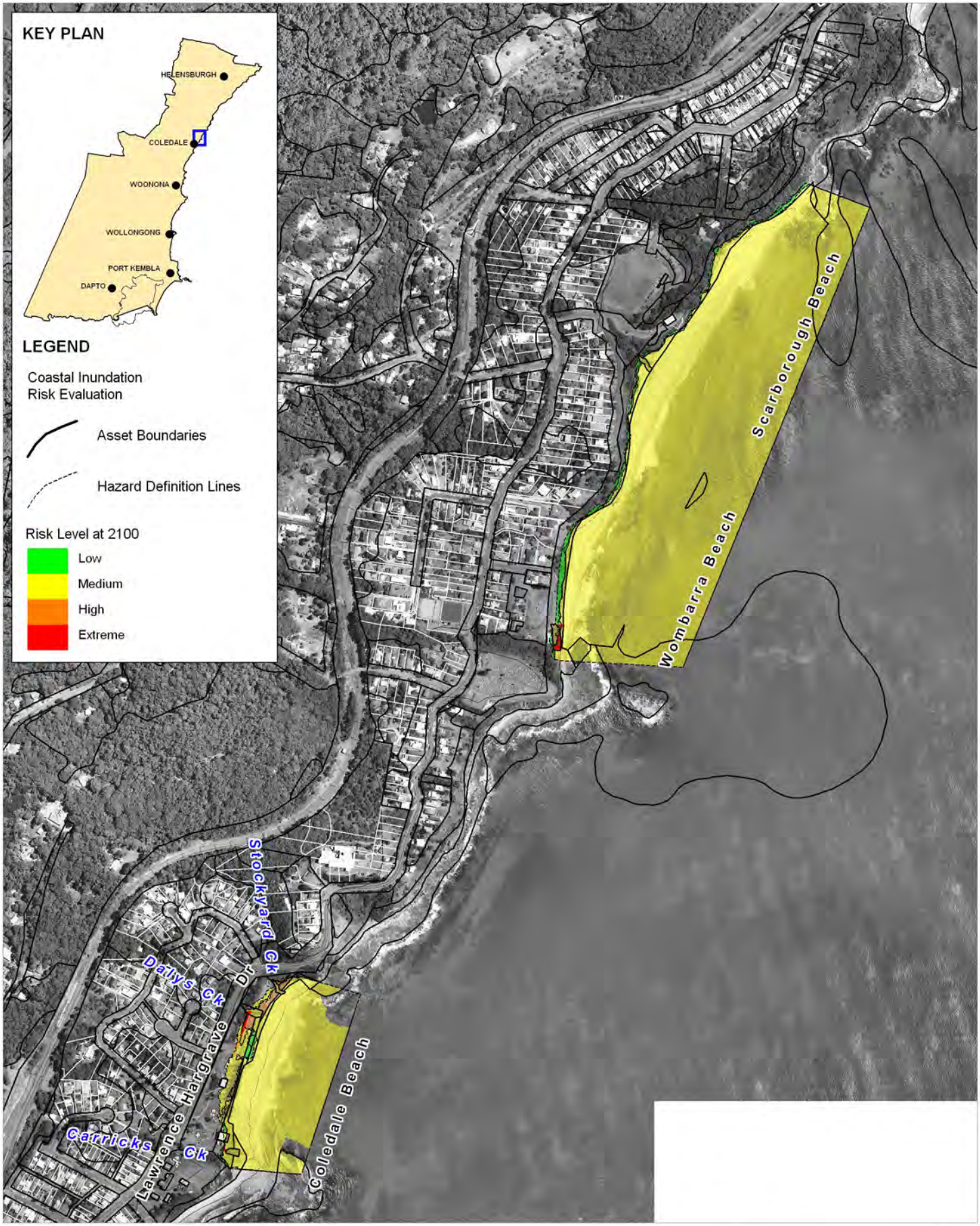
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_224_110419 Drawing F-2.WOR



Title:

Coastal Inundation Risk Evaluation
2100 Planning Horizon - Scarborough/Coledale

Drawing: F-3

Rev: A

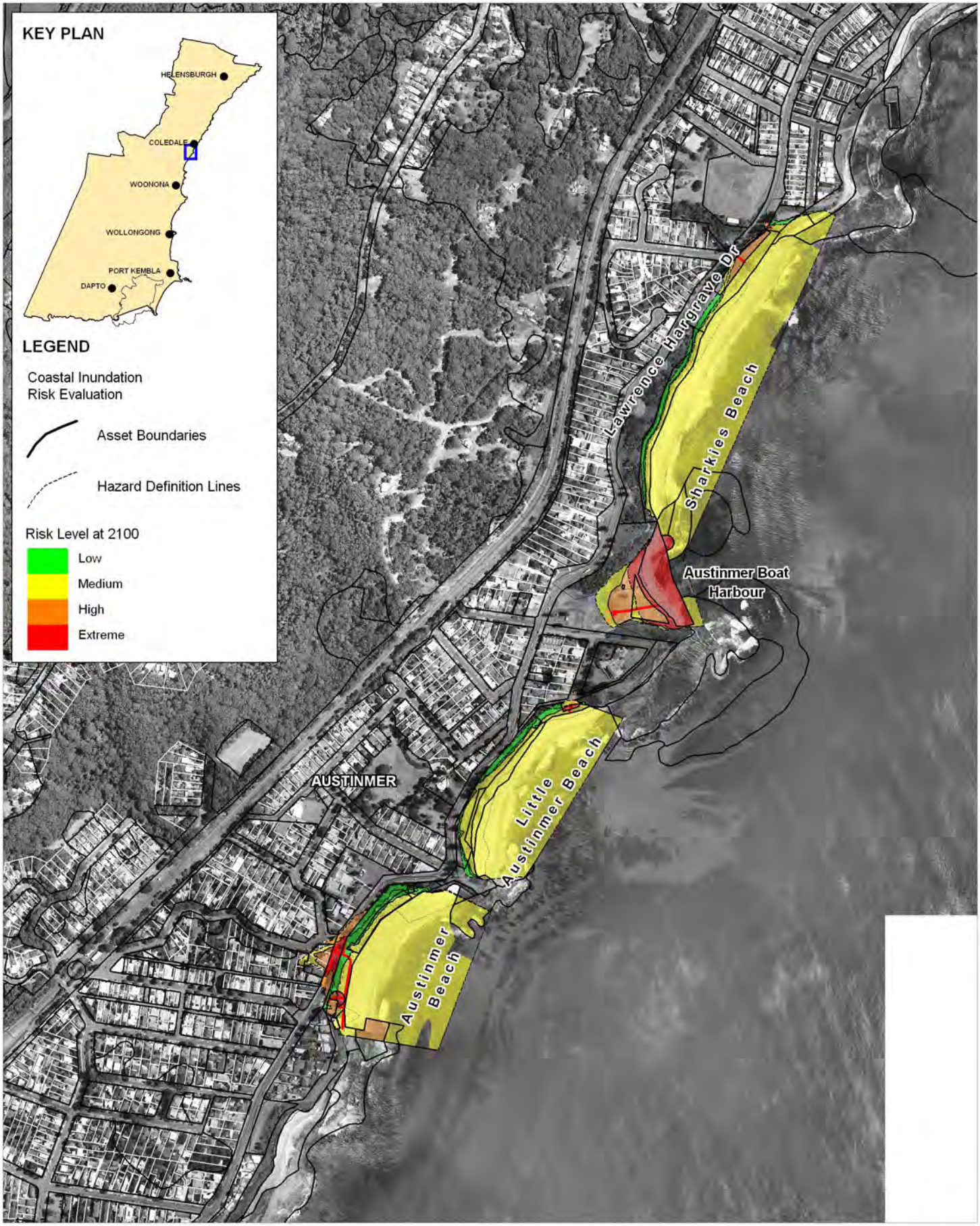
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_225_110419 Drawing F-3.WOR



Title:

Coastal Inundation Risk Evaluation
2100 Planning Horizon - Austinmer

Drawing: F-4

Rev: A

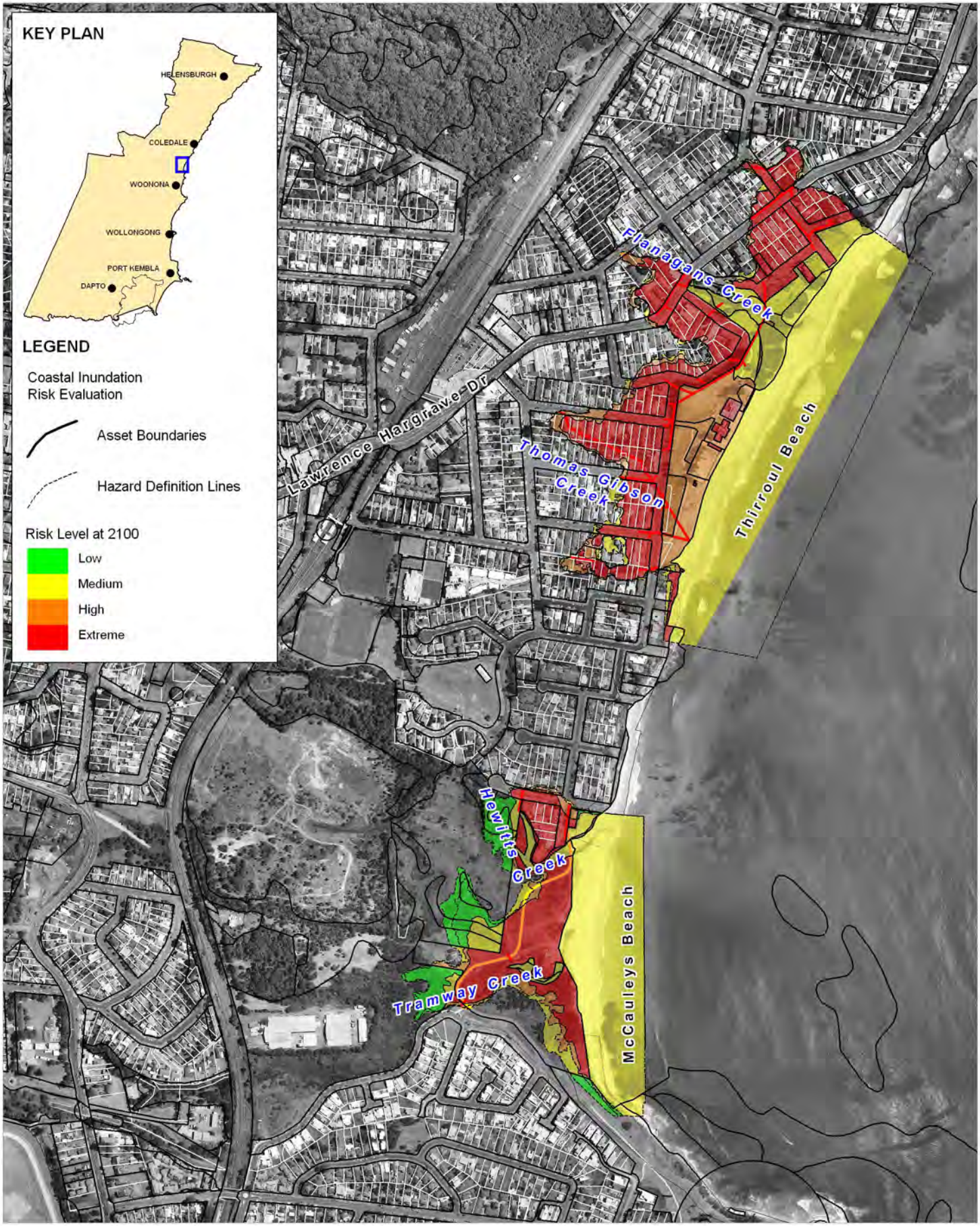
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_226_110419 Drawing F-4.WOR



Title:

Coastal Inundation Risk Evaluation
2100 Planning Horizon - Thirroul/McCauleys

Drawing: F-5

Rev: A

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N

0 200 400m

Approx. Scale

BMT WBM
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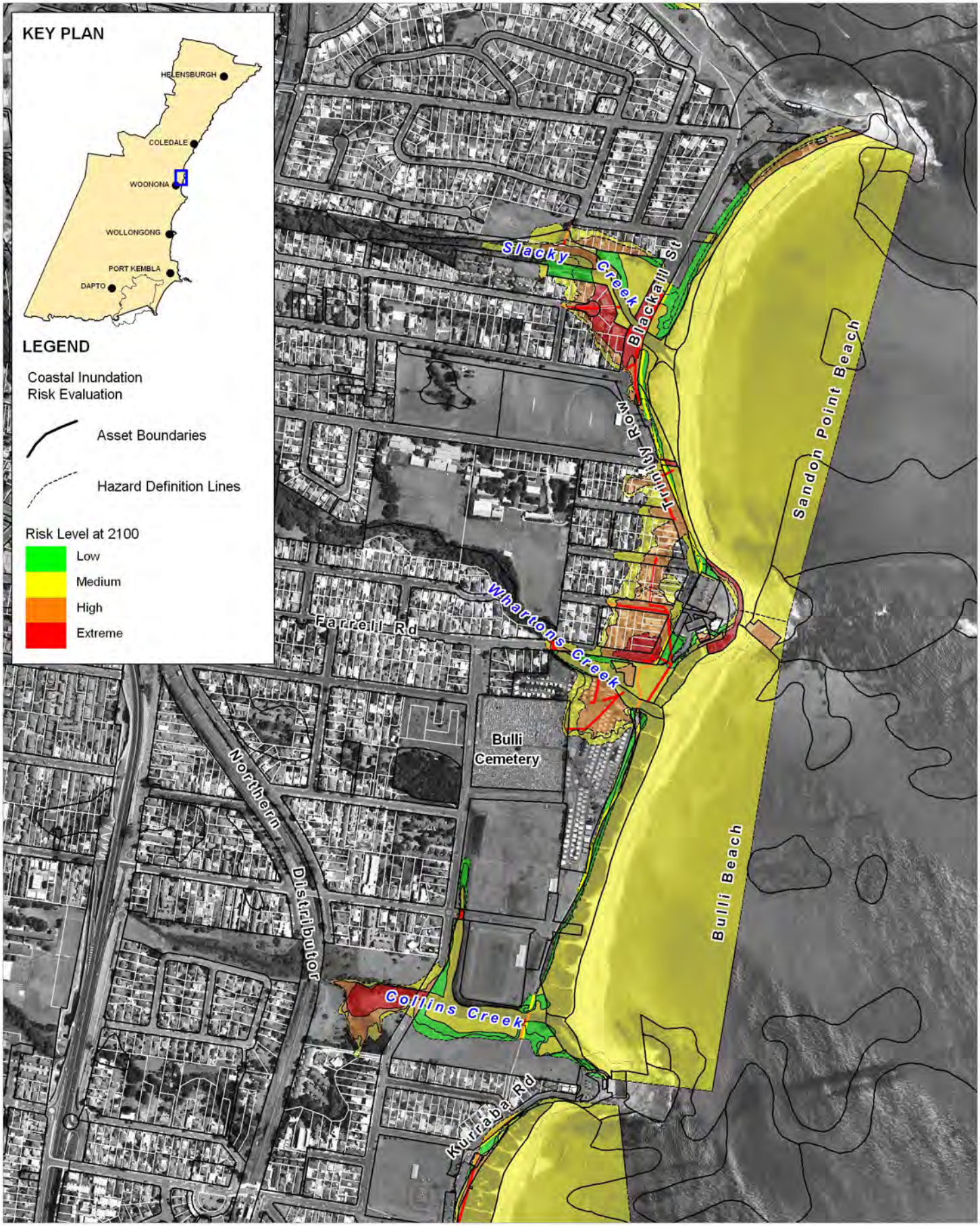

Title:

Coastal Inundation Risk Evaluation
2100 Planning Horizon - Sandon/Bulli

Drawing: F-6

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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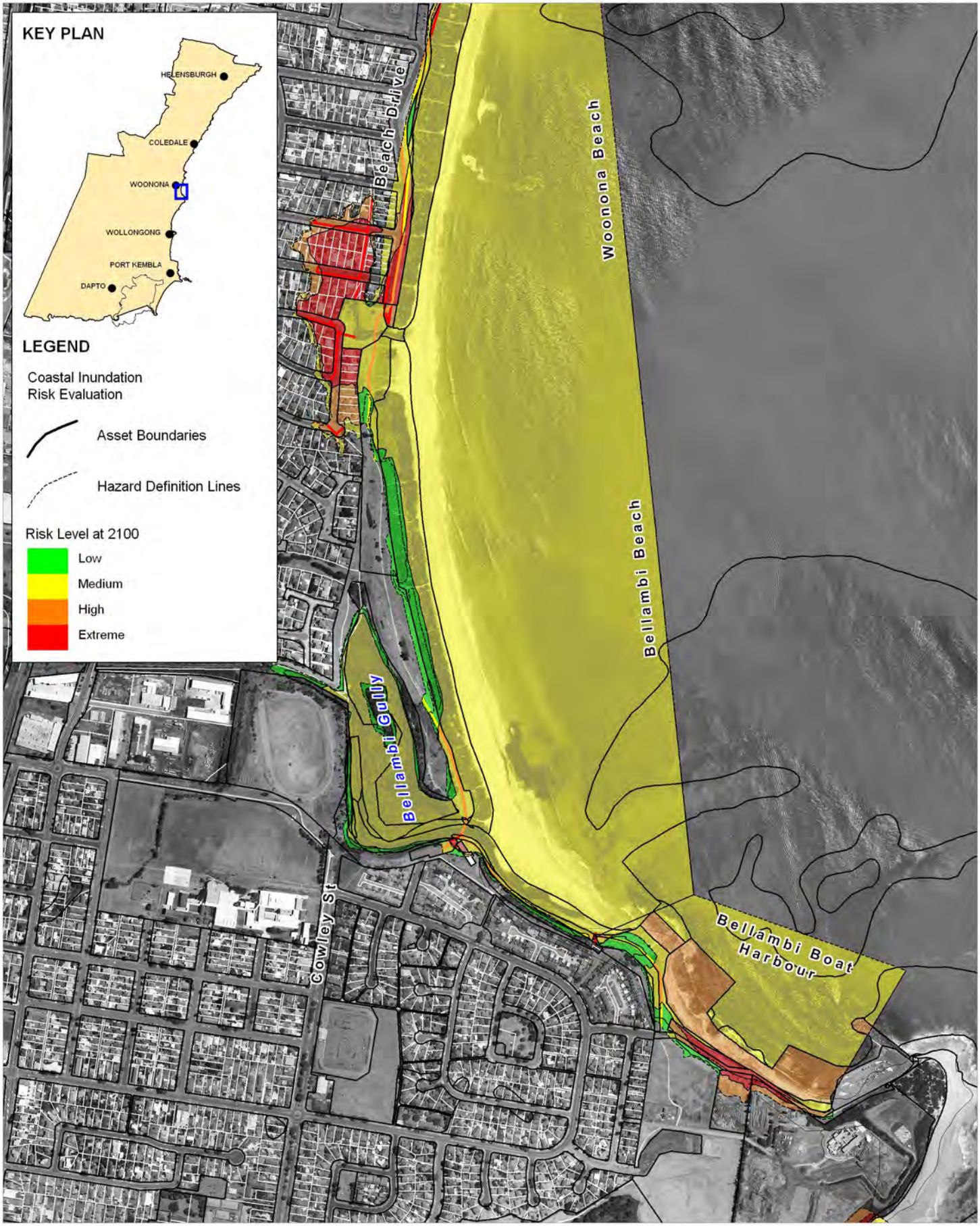

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2100 Planning Horizon - Woonona/Bellambi

Drawing: F-7

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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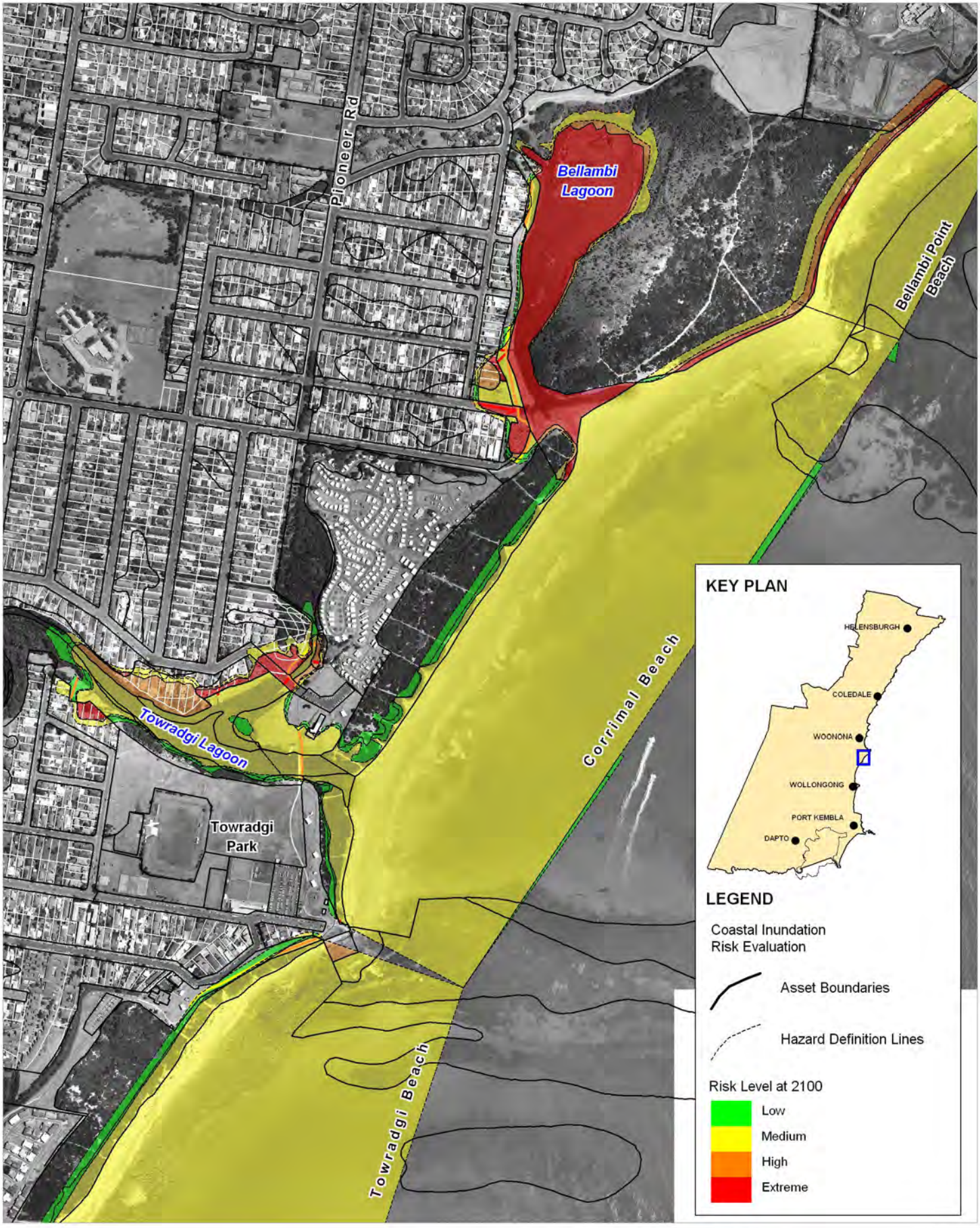

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2100 Planning Horizon - Corrimal Beach

Drawing: F-8

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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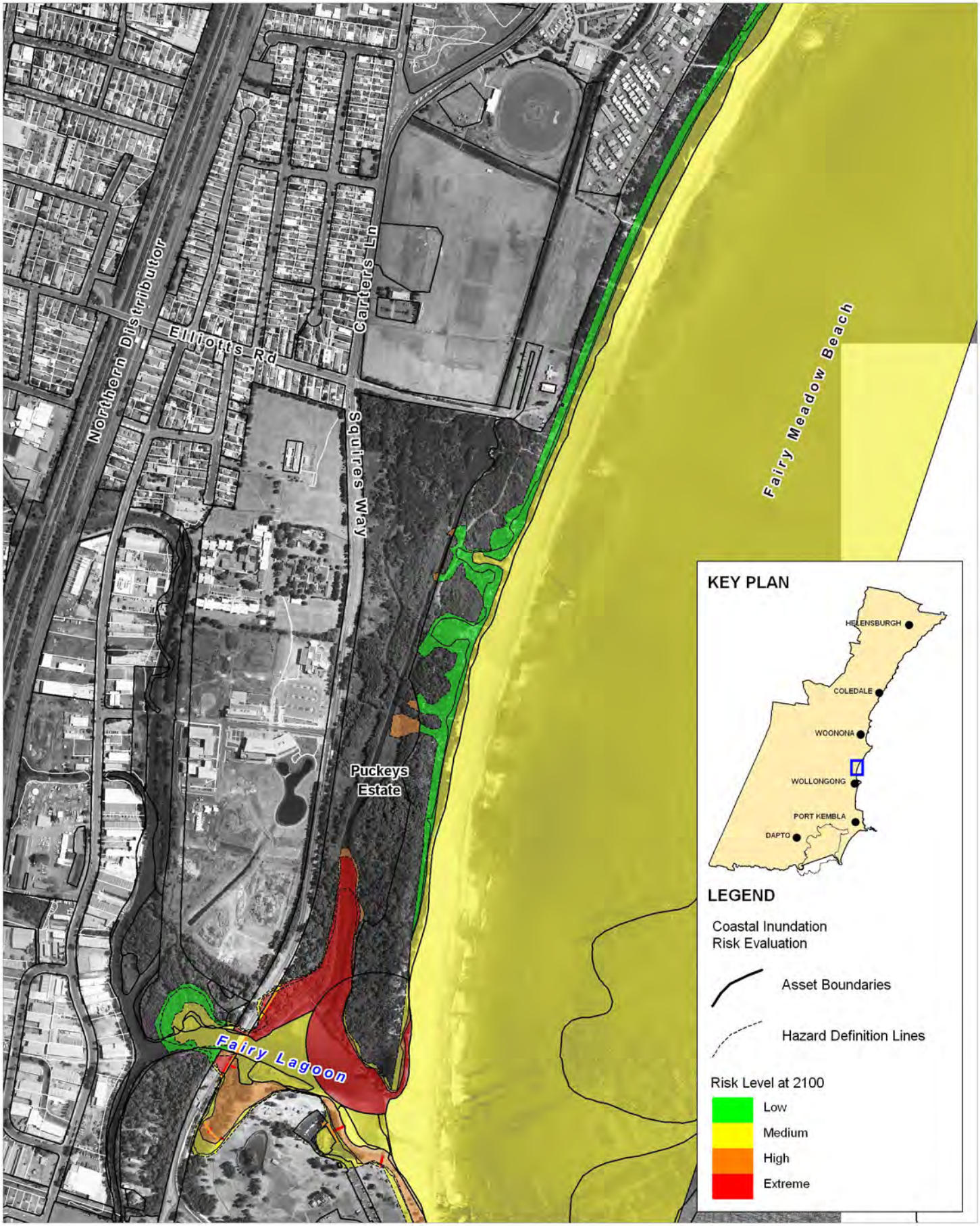

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2100 Planning Horizon - Fairy Meadow

Drawing: F-9

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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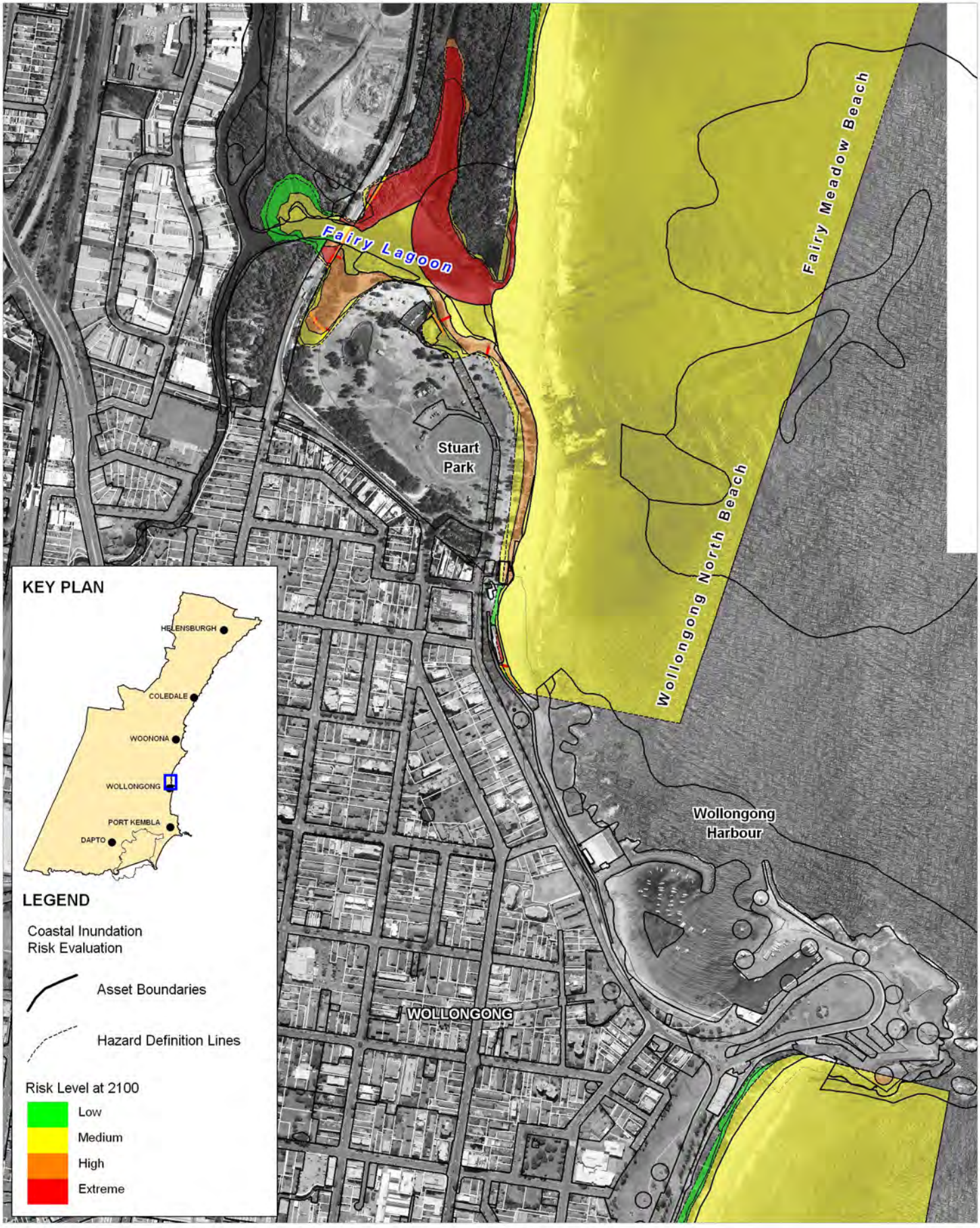

Title:

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2100 Planning Horizon - Wollongong

Drawing: F-10

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 200 400m

Approx. Scale

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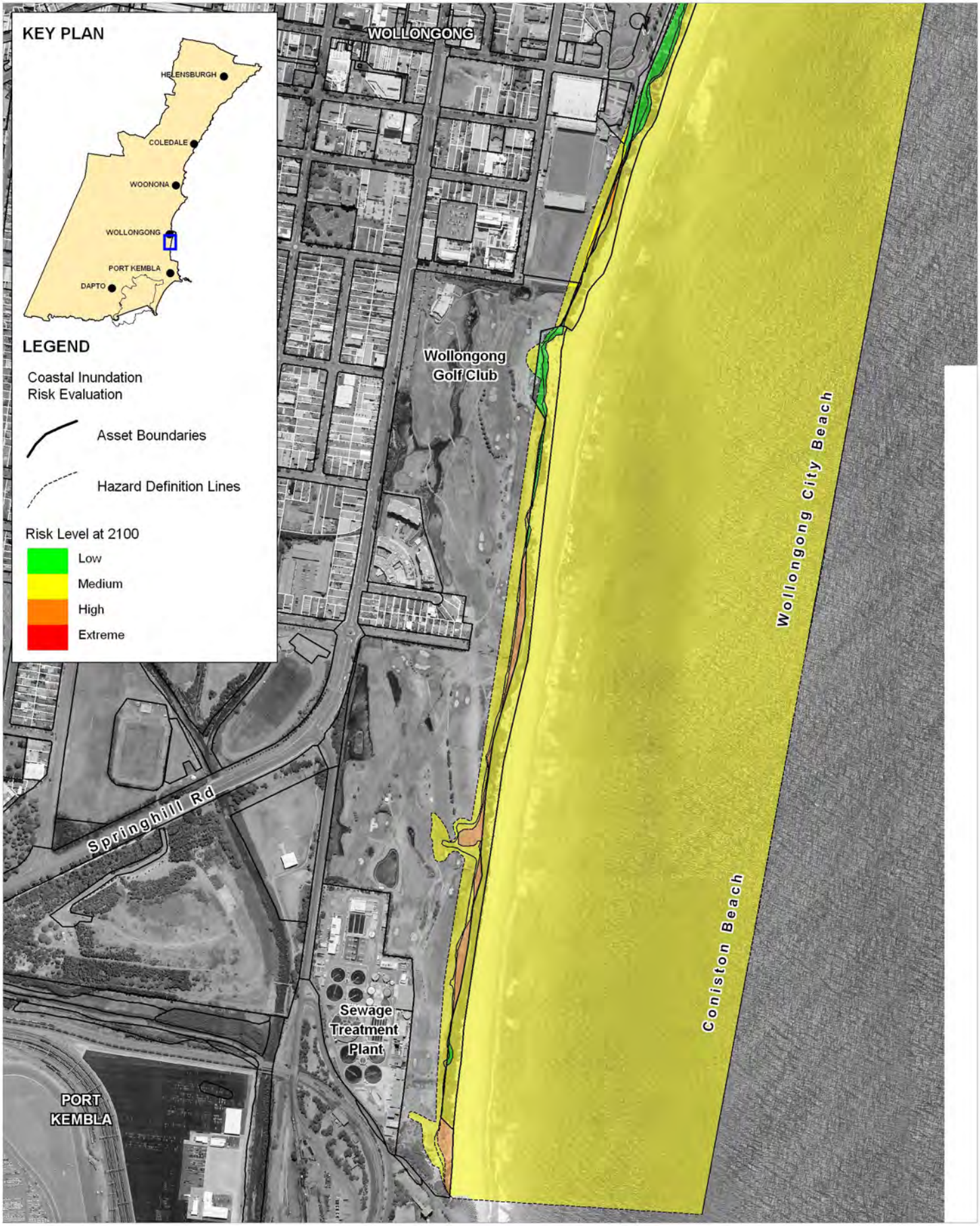

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2100 Planning Horizon - Wollongong City Beach

Drawing: F-11

Rev: A

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0 200 400m

Approx. Scale

BMT WBM
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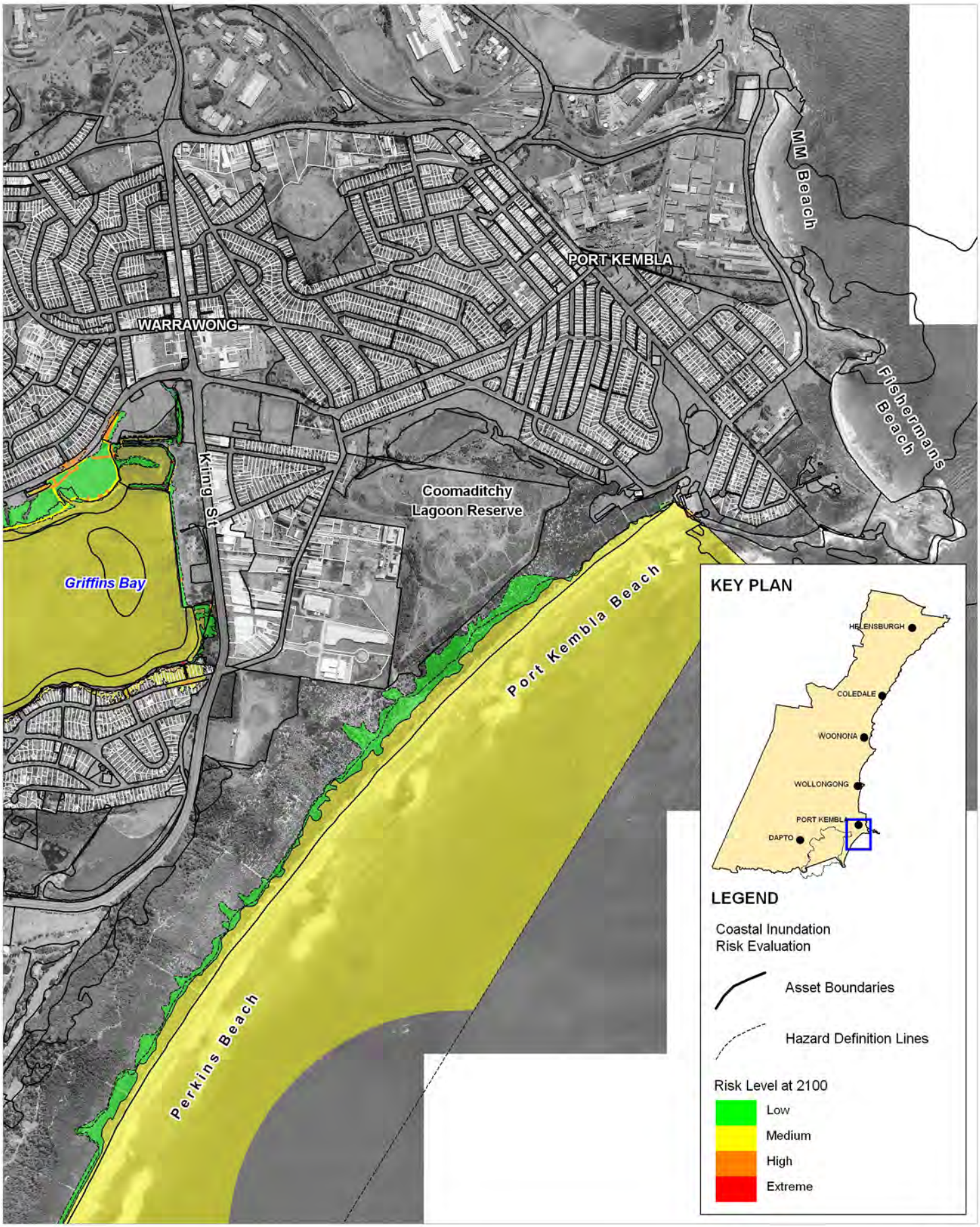

Title:

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2100 Planning Horizon - Port Kembla

Drawing: F-12

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM
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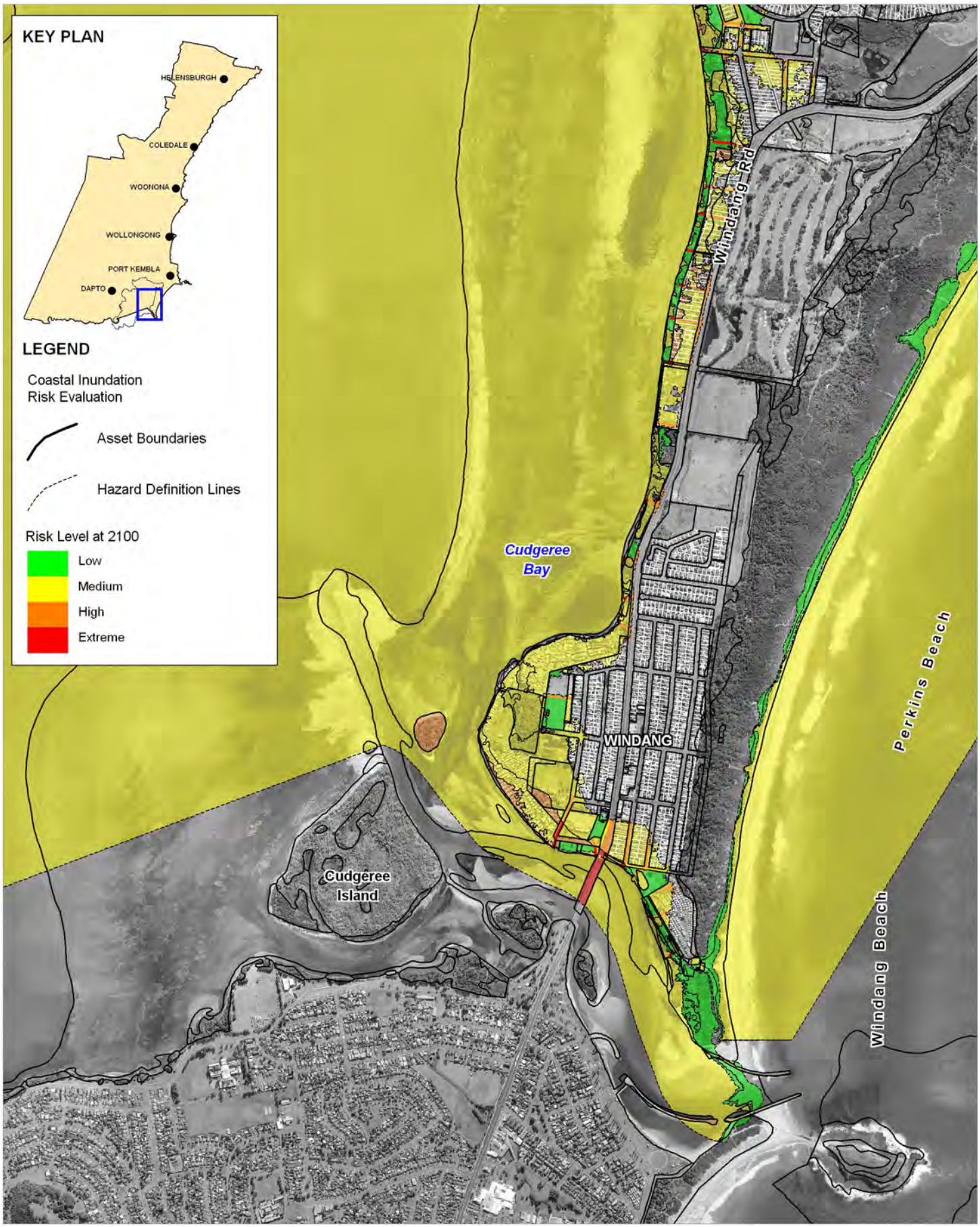
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_234_110419 Drawing F-12.WOR



Title:

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2100 Planning Horizon - Windang

Drawing: F-13

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM
www.wbmpl.com.au

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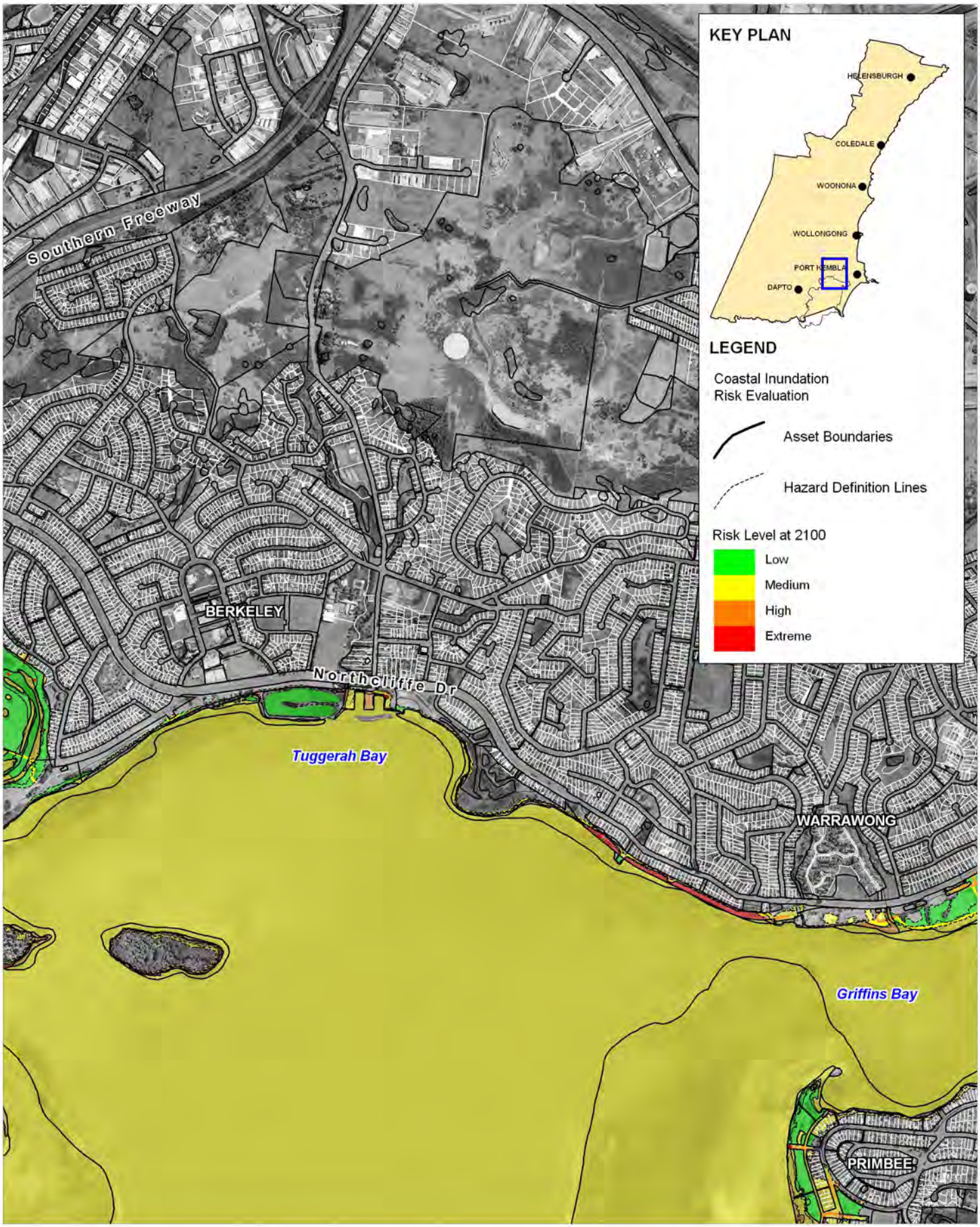

Title:

Coastal Inundation Risk Evaluation
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Drawing: F-14

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM

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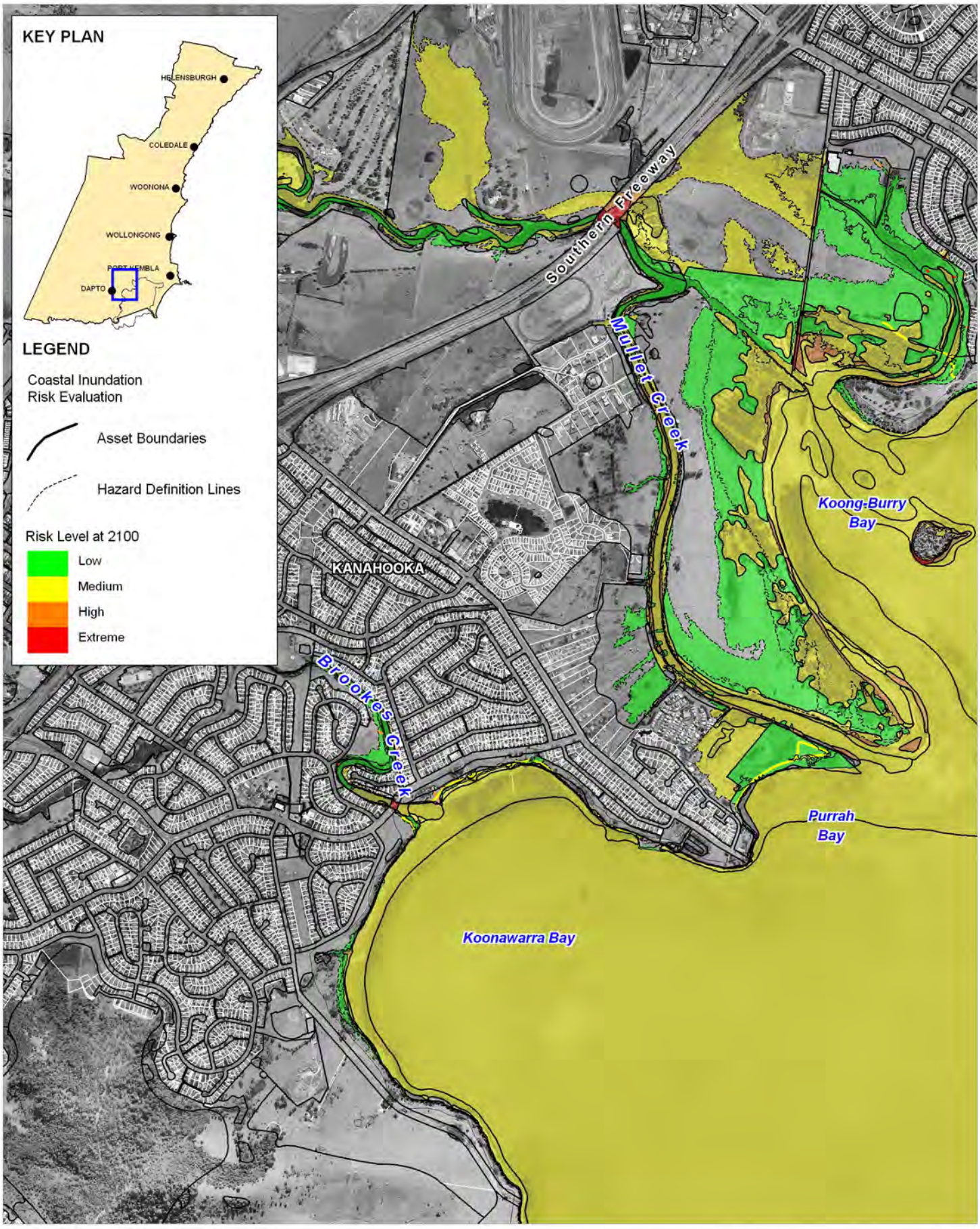
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_236_110419 Drawing F-14.WOR



Title:

Coastal Inundation Risk Evaluation 2100 Planning Horizon - Kanahooka

Drawing: F-15

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM

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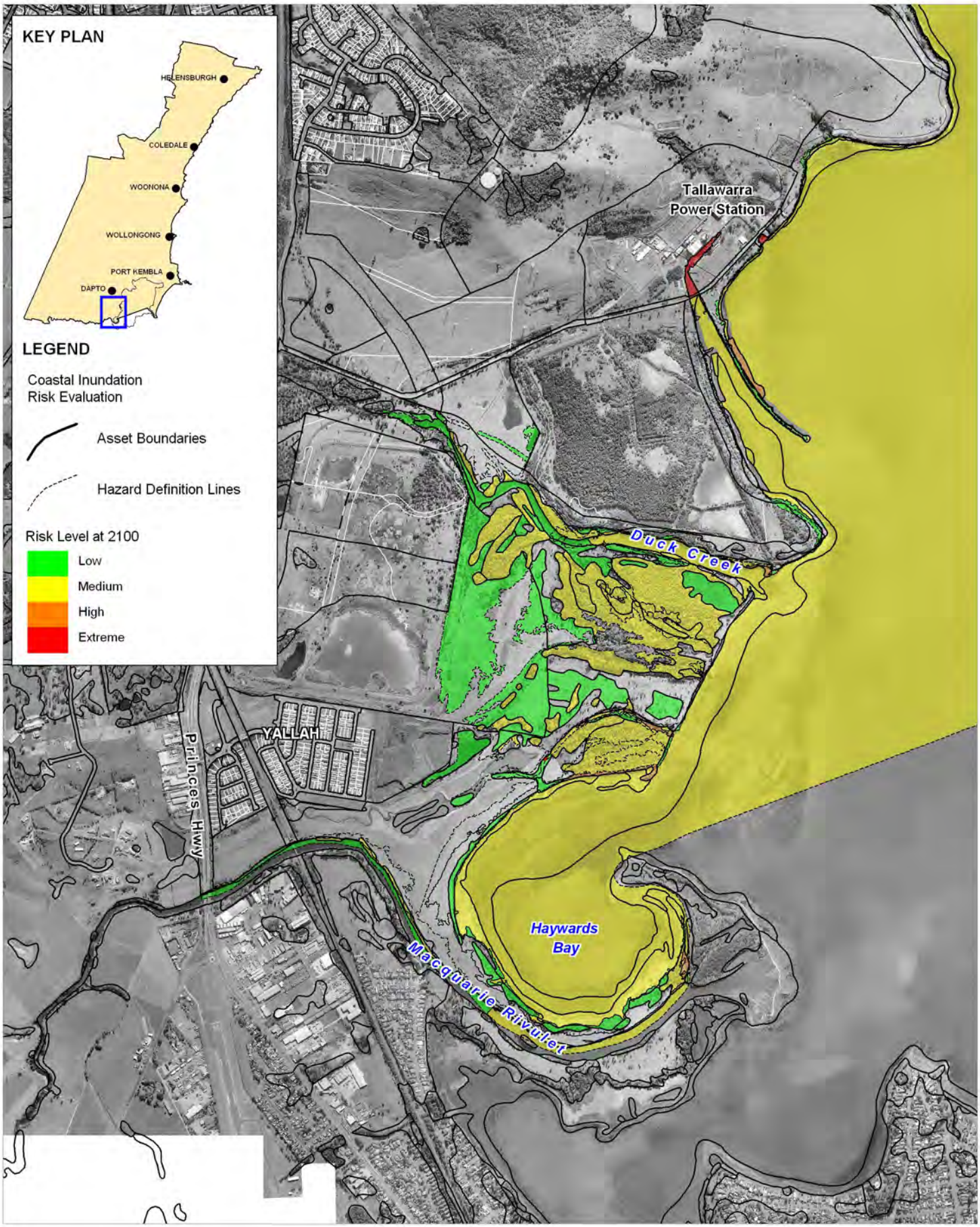

Title:

Coastal Inundtion Risk Evaluation 2100 Planning Horizon - Tallawarra

Drawing: F-16

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM

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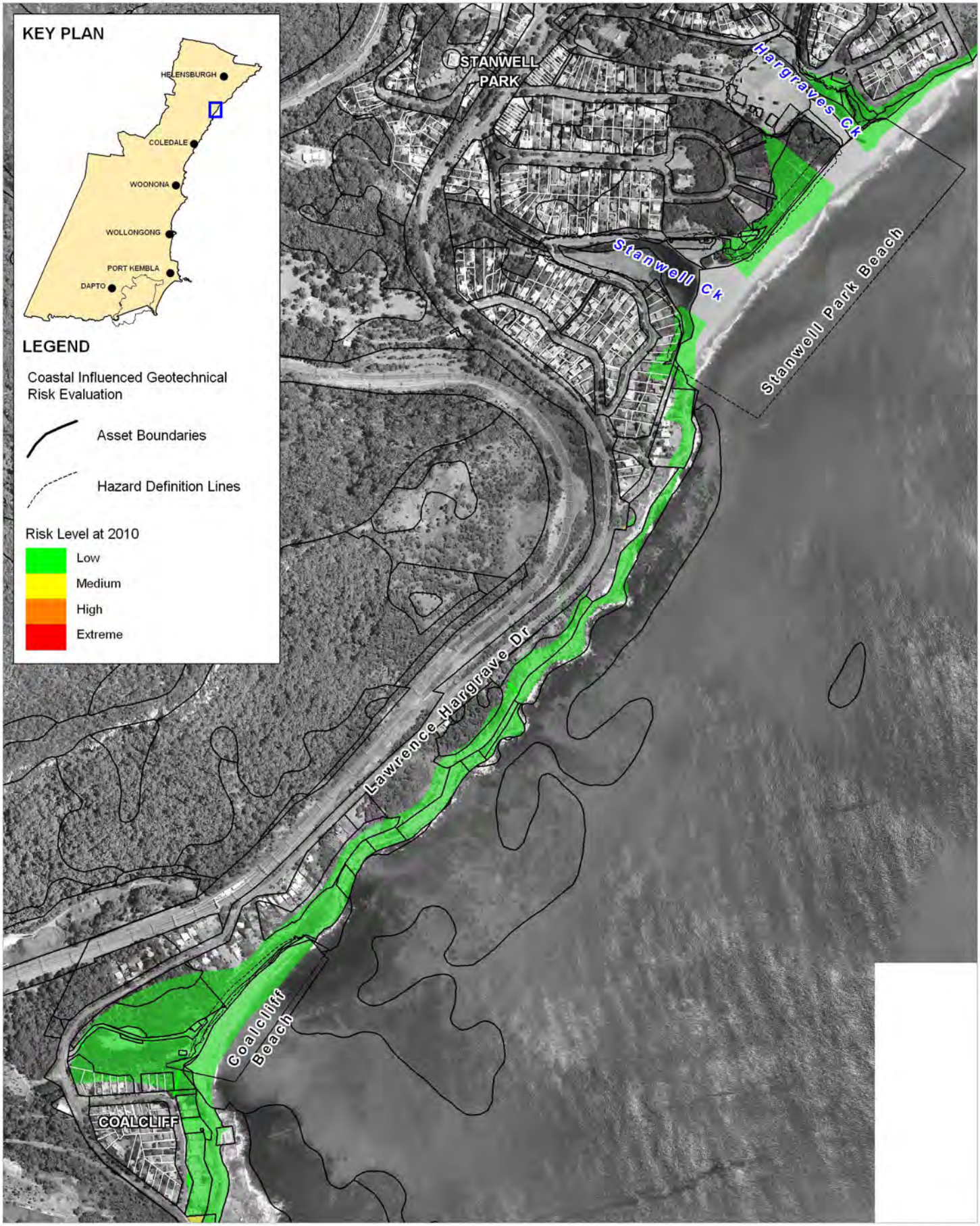

Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Stanwell Park / Coalcliff

Drawing: G-1

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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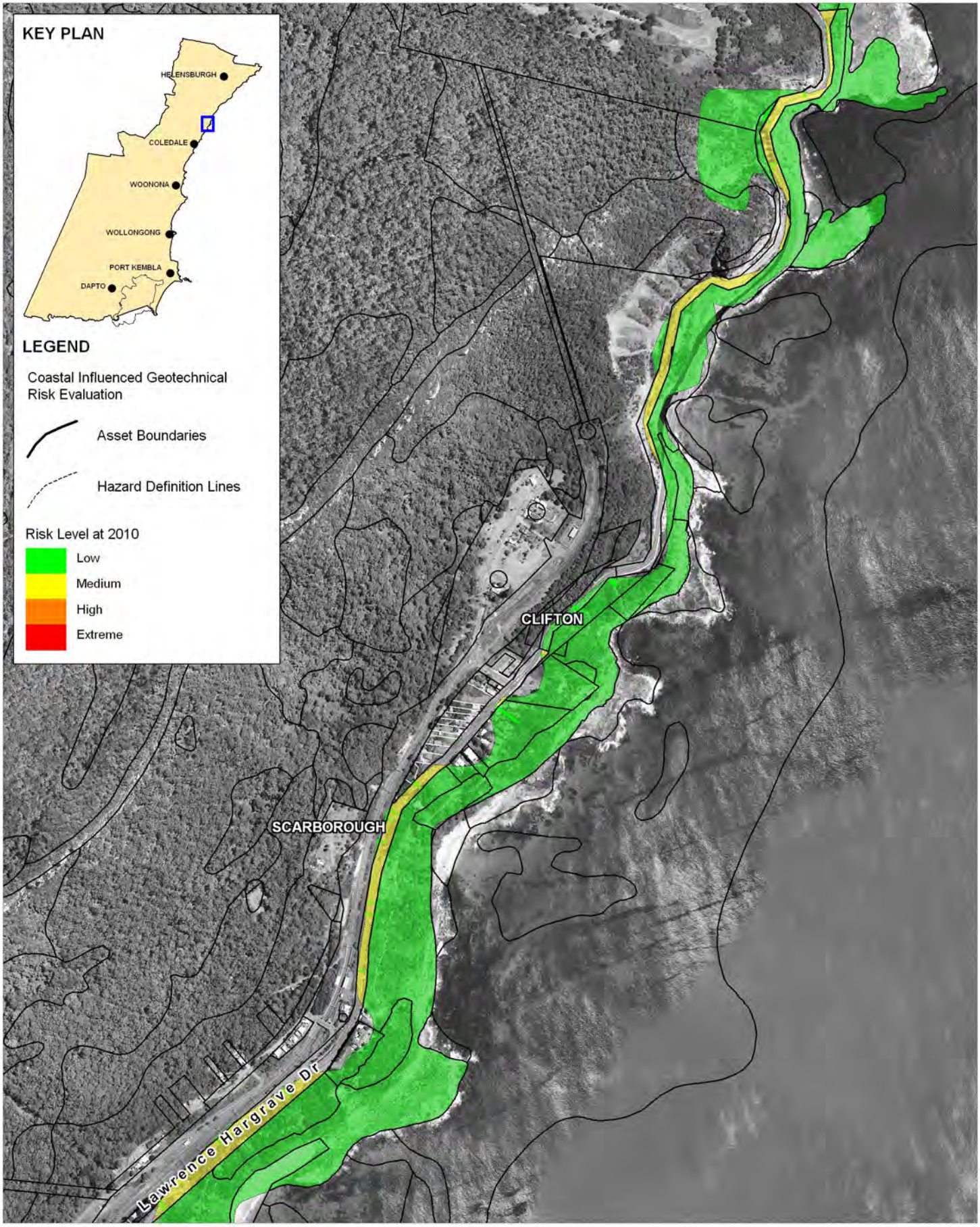
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_239_110419 Drawing G-1.WOR



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Immediate Planning Horizon - Clifton / Scarborough

Drawing: G-2

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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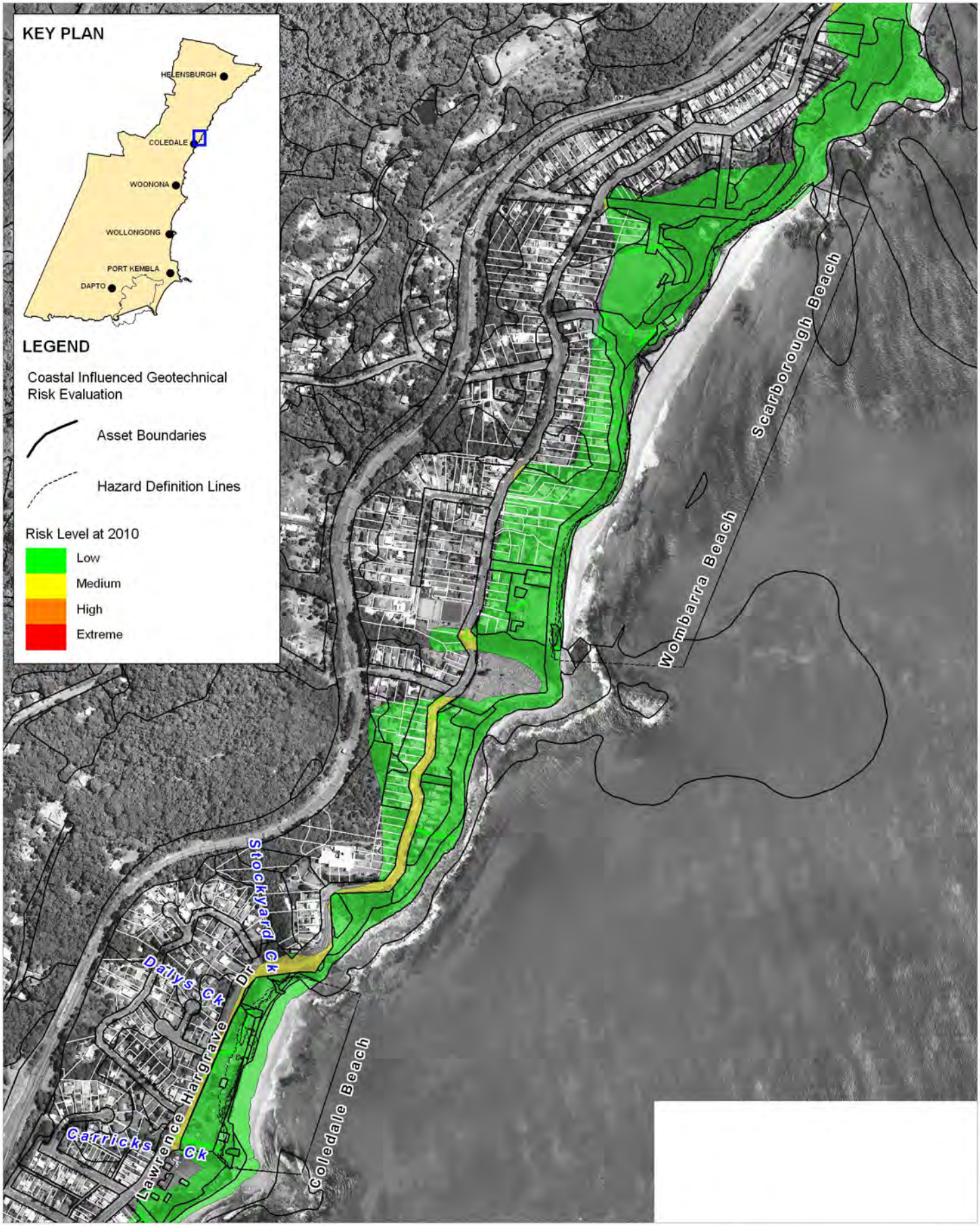

Title:

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Immediate Planning Horizon - Scarborough/Coledale

Drawing: G-3

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

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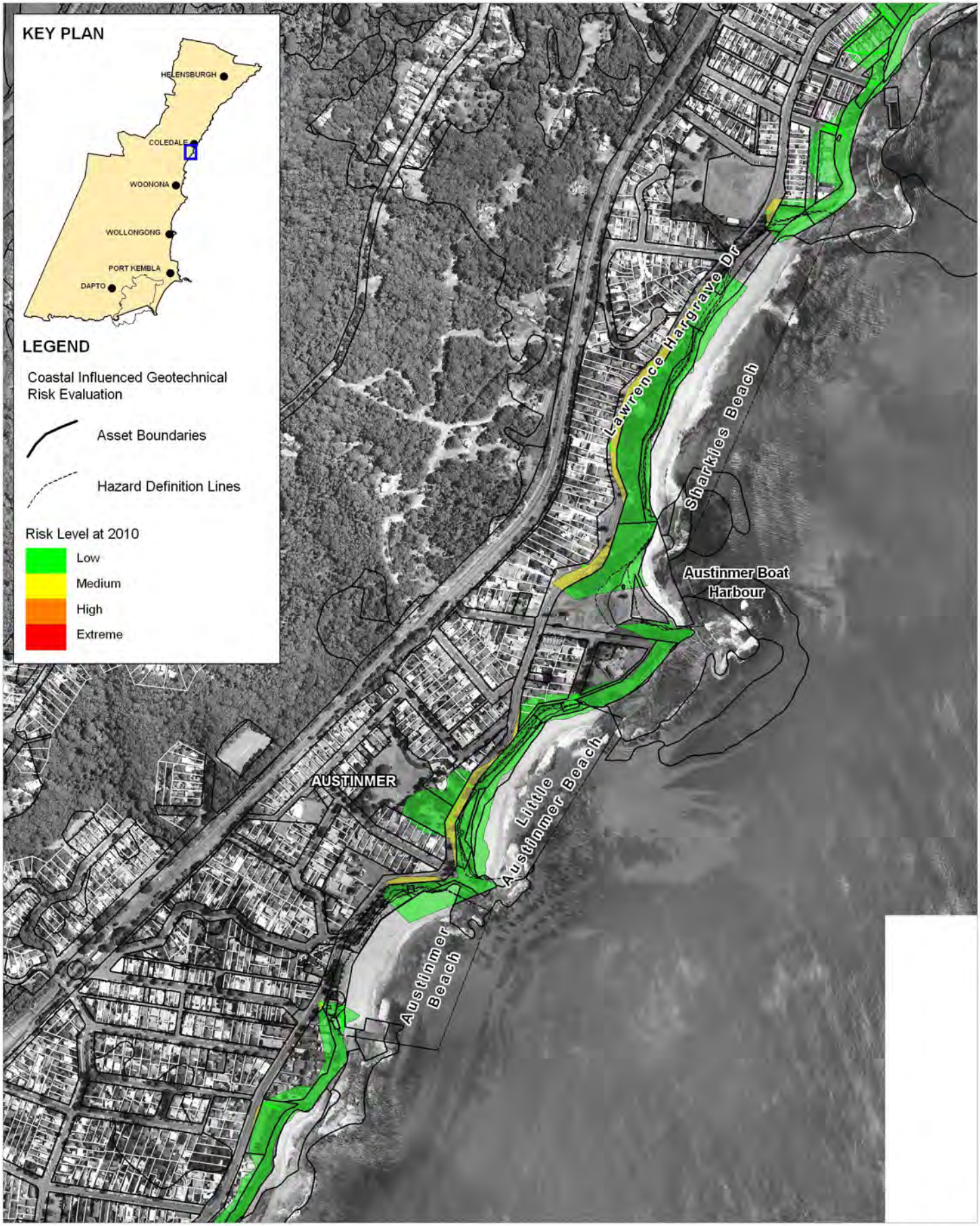

Title:

Coastal Influanced Geotechnical Risk Evaluation
Immediate Planning Horizon - Austinmer

Drawing: G-4

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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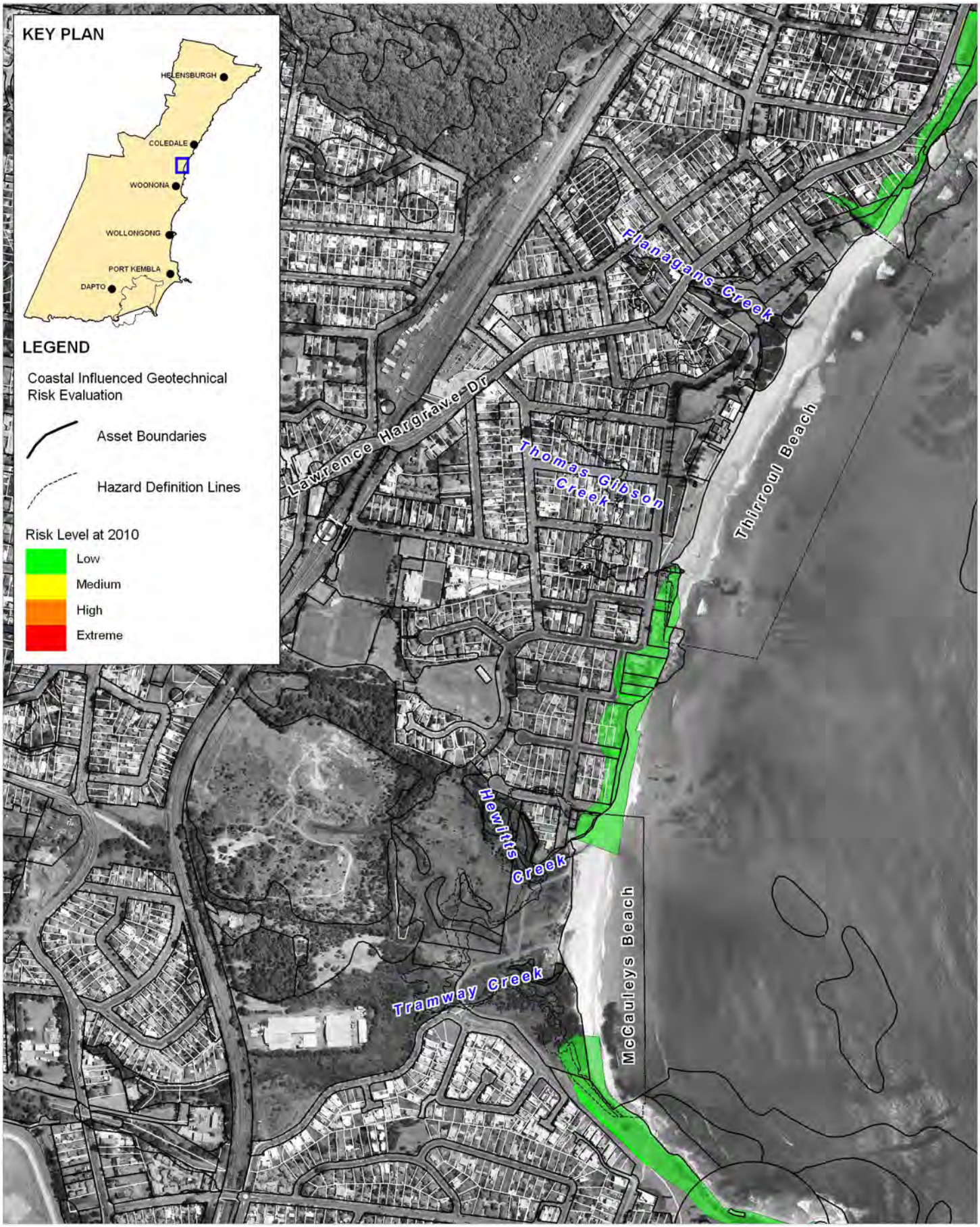


Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Thirroul/McCauleys

Drawing: G-5

Rev: A

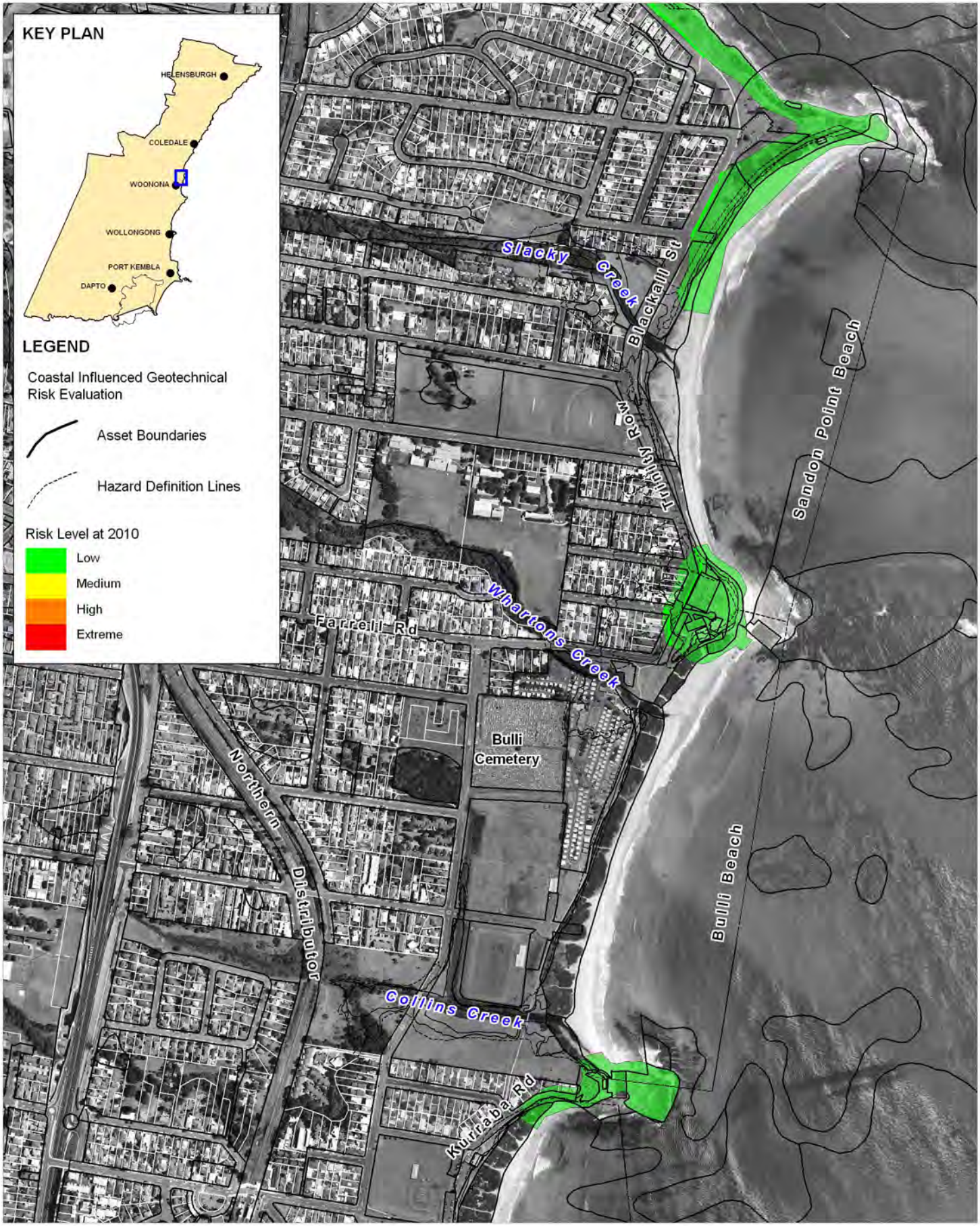
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_243_110419 Drawing G-5.WOR



Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Sandon/Bulli

Drawing: G-6

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
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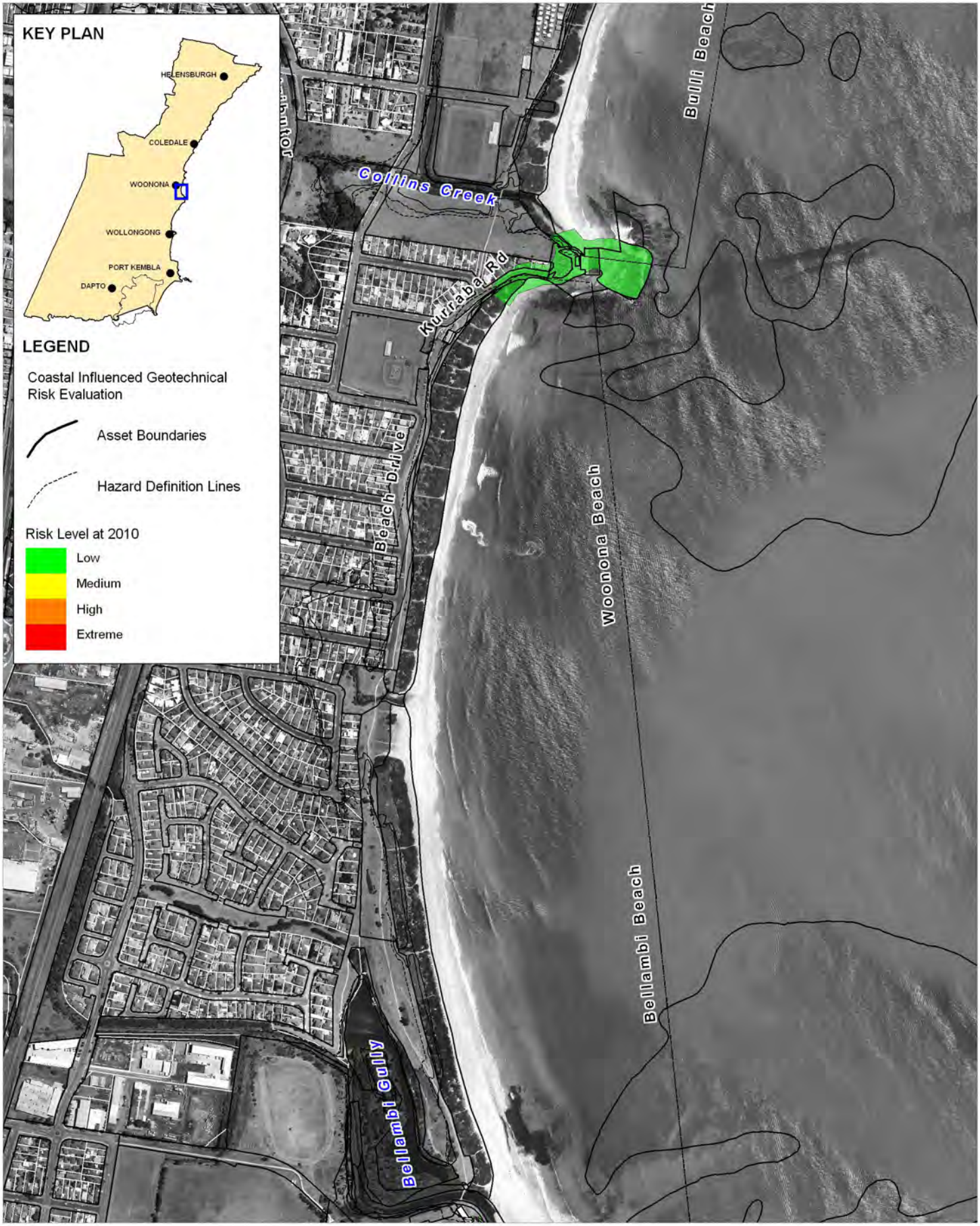

Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Woonona/Bellambi

Drawing: G-7

Rev: A

N

0 200 400m

Approx. Scale

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www.wbmpl.com.au

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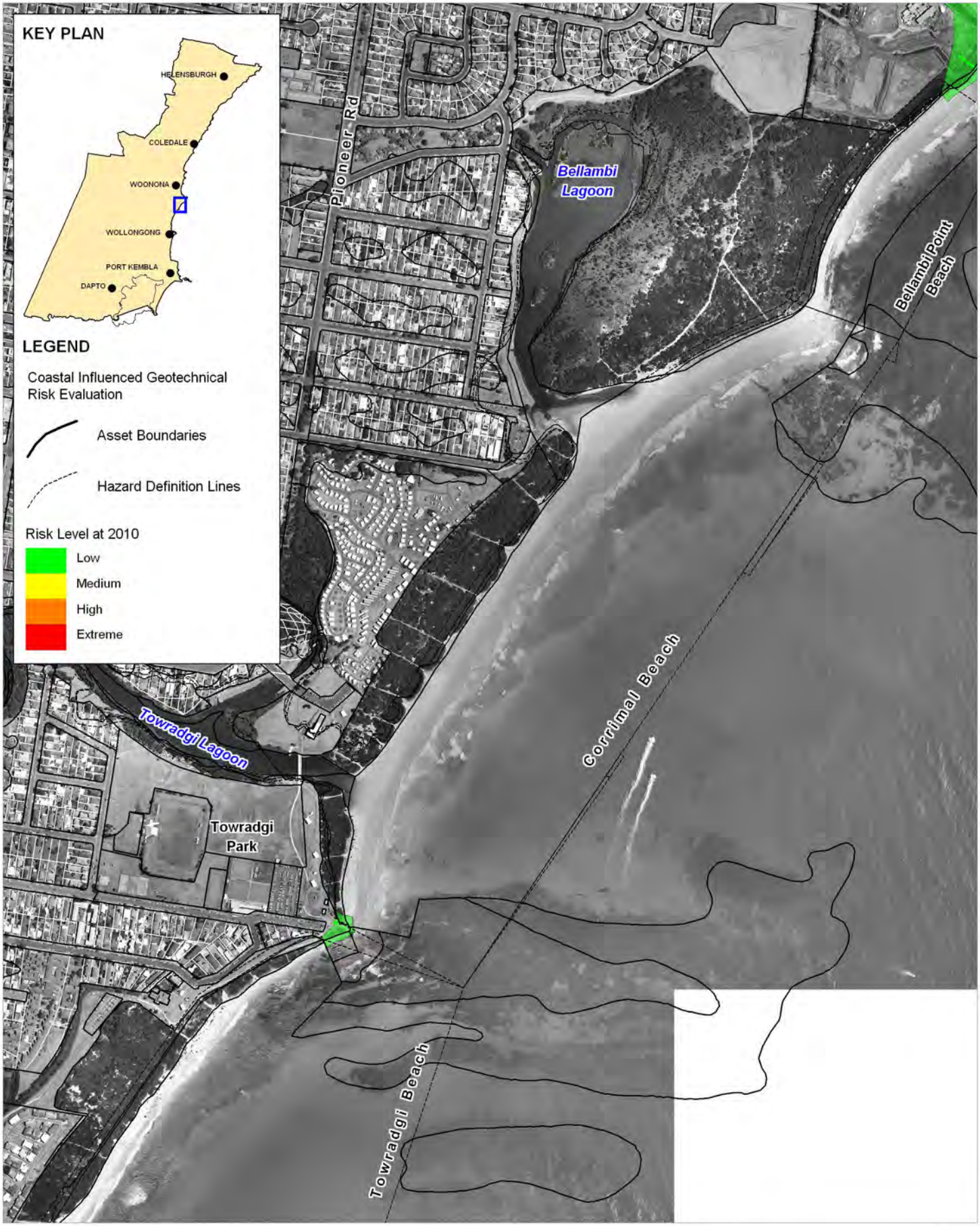

Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Corrimal Beach

Drawing: G-8

Rev: A

N

0 200 400m

Approx. Scale

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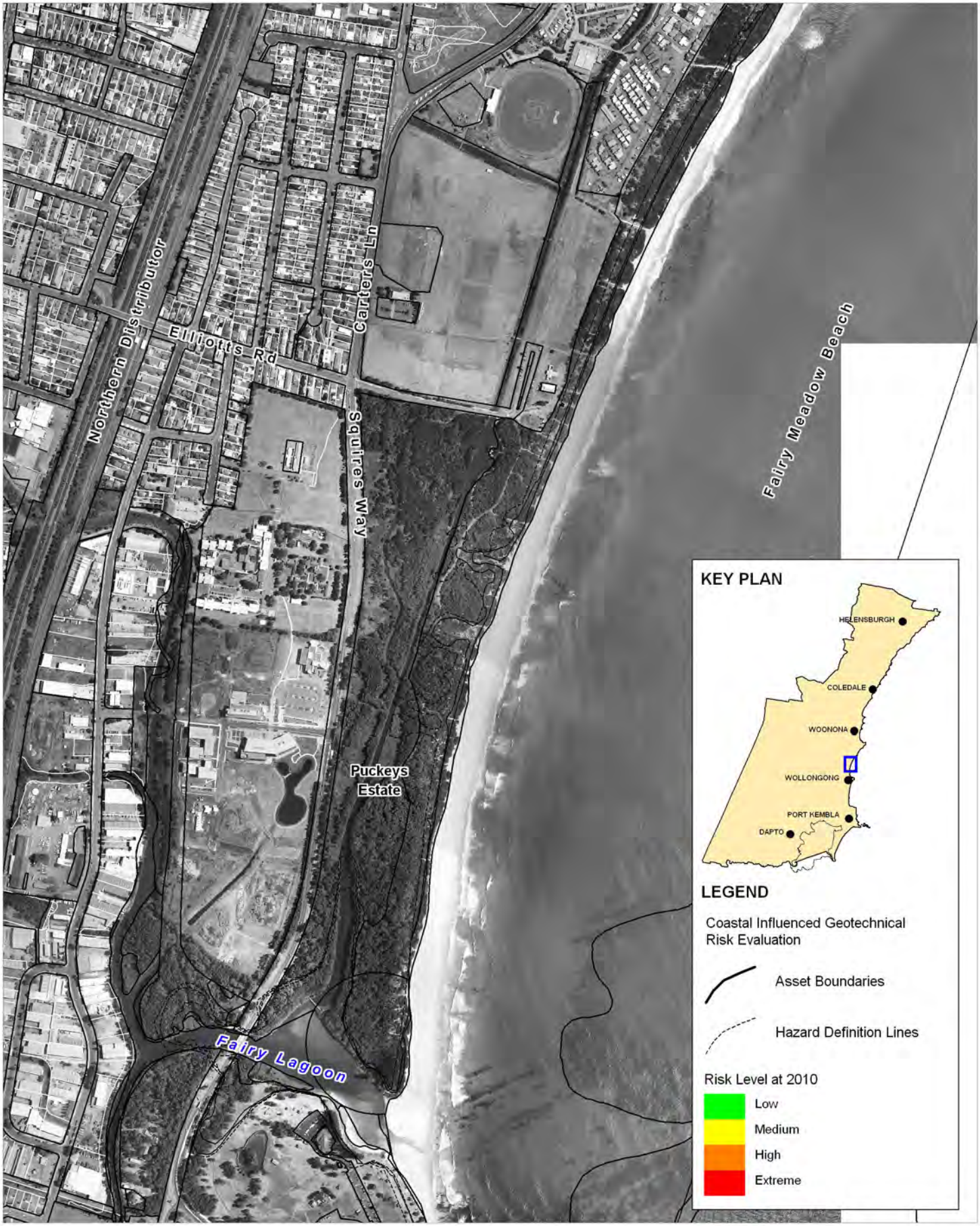

Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Fairy Meadow

Drawing: G-9

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

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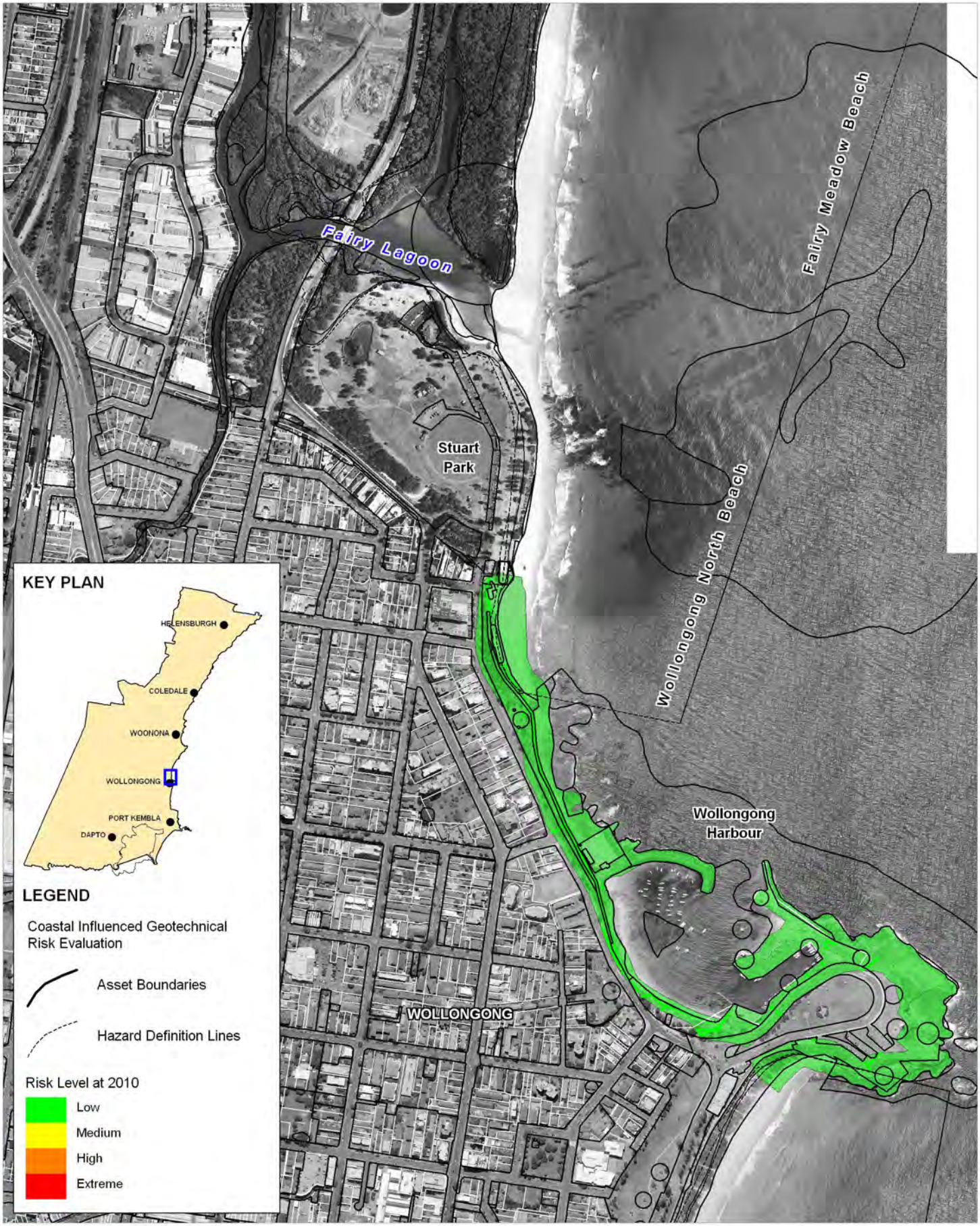

Title:

Coastal Influenced Geotechnical Risk Evaluation Immediate Planning Horizon - Wollongong

Drawing: G-10

Rev: A

N

0 200 400m

Approx. Scale

BMT WBM

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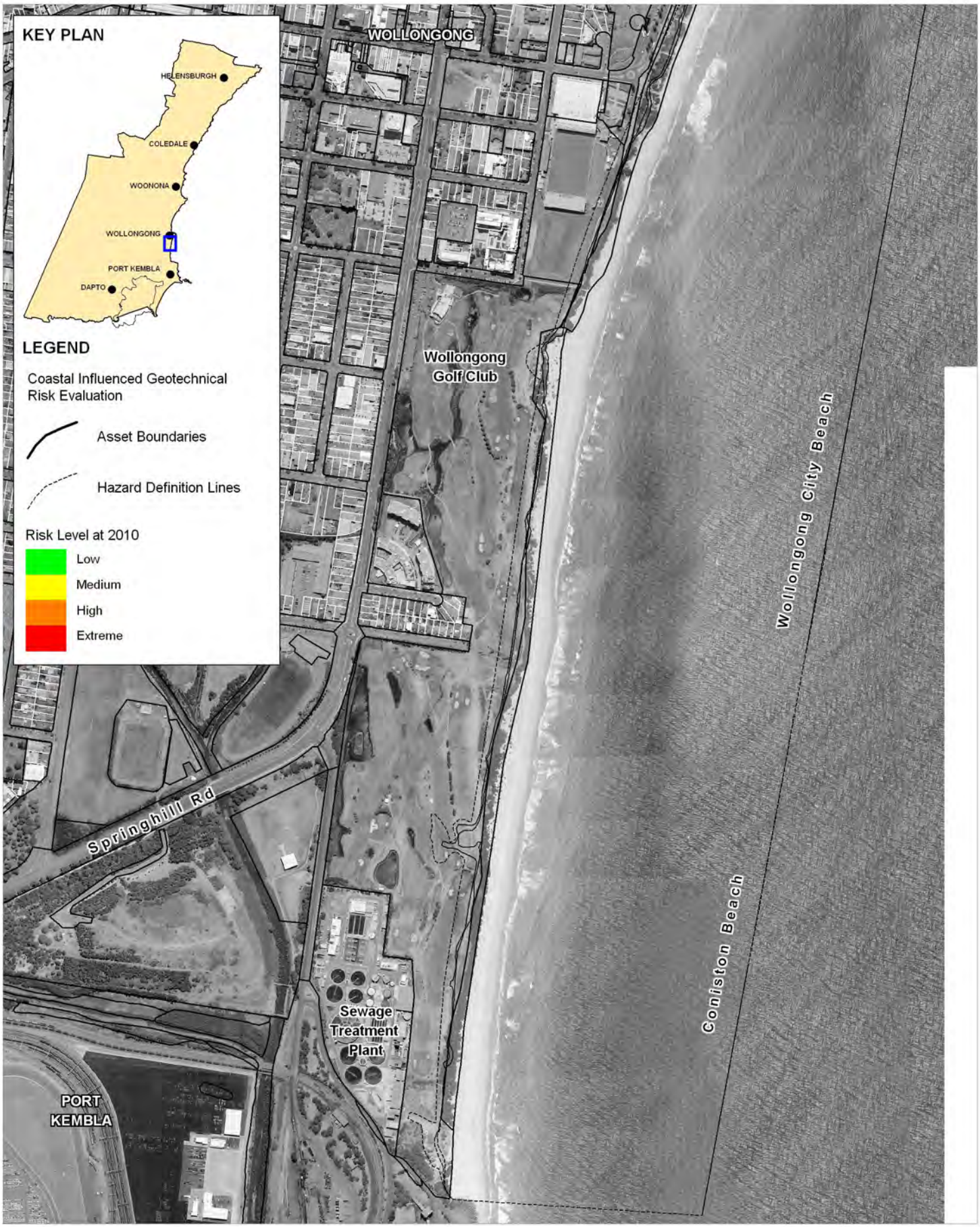


Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Wollongong City Beach

Drawing: G-11

Rev: A

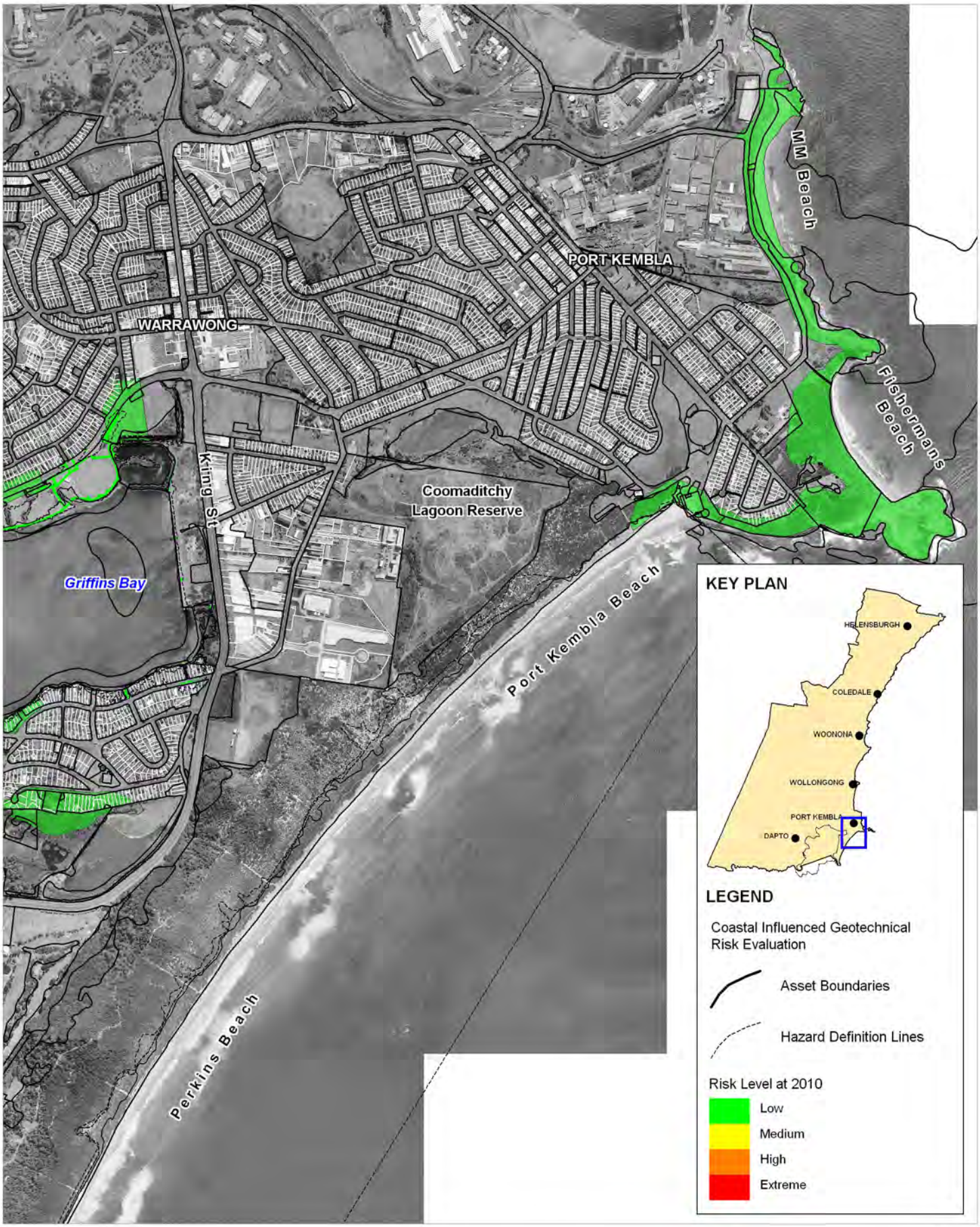
N

0 200 400m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_249_110419 Drawing G-11.WOR



Title:

Coastal Influenced Geotechnical Risk Evaluation Immediate Planning Horizon - Port Kembla

Drawing: G-12

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

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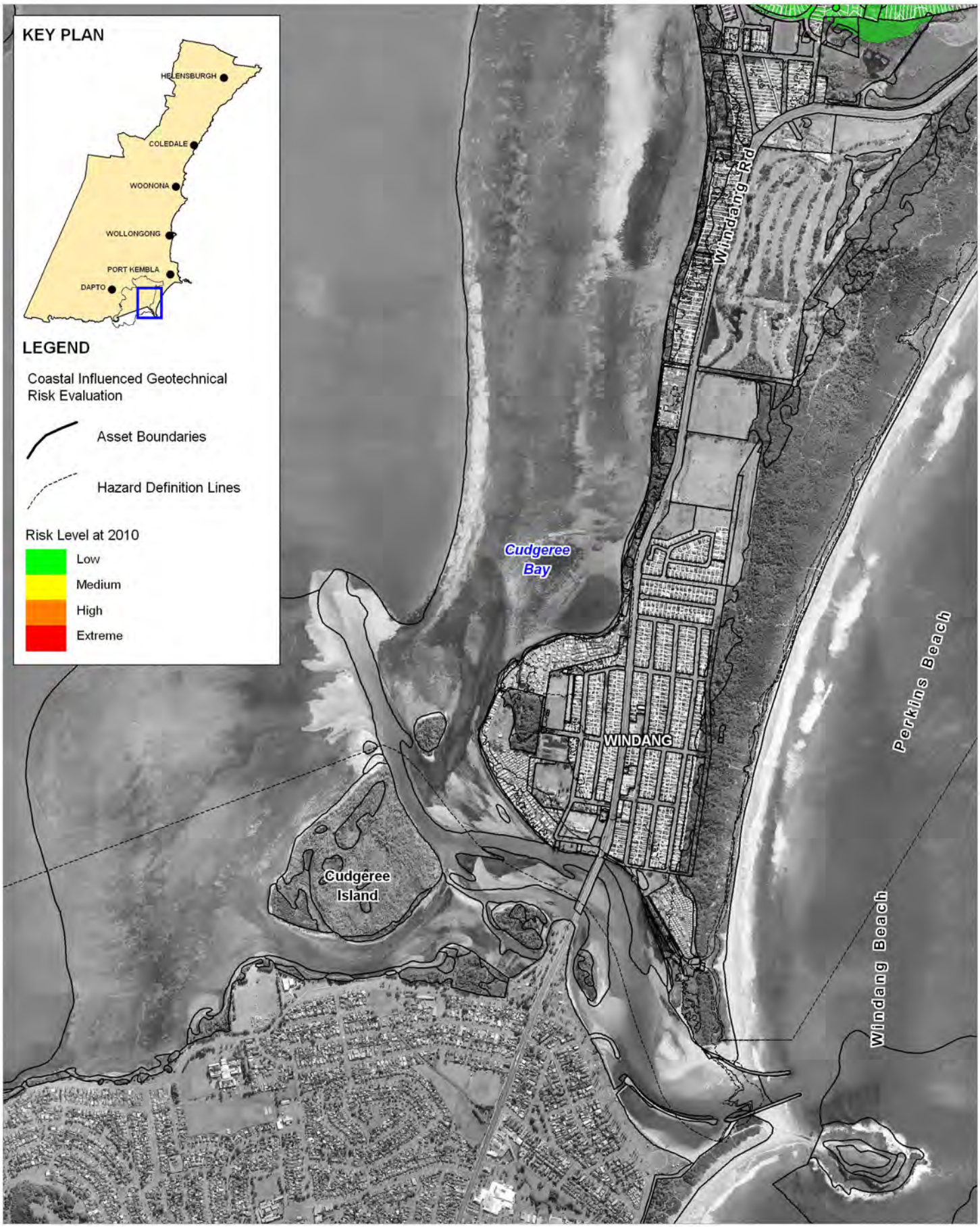


Title:

Coastal Influenced Geotechnical Risk Evaluation Immediate Planning Horizon - Windang

Drawing: G-13

Rev: A

N

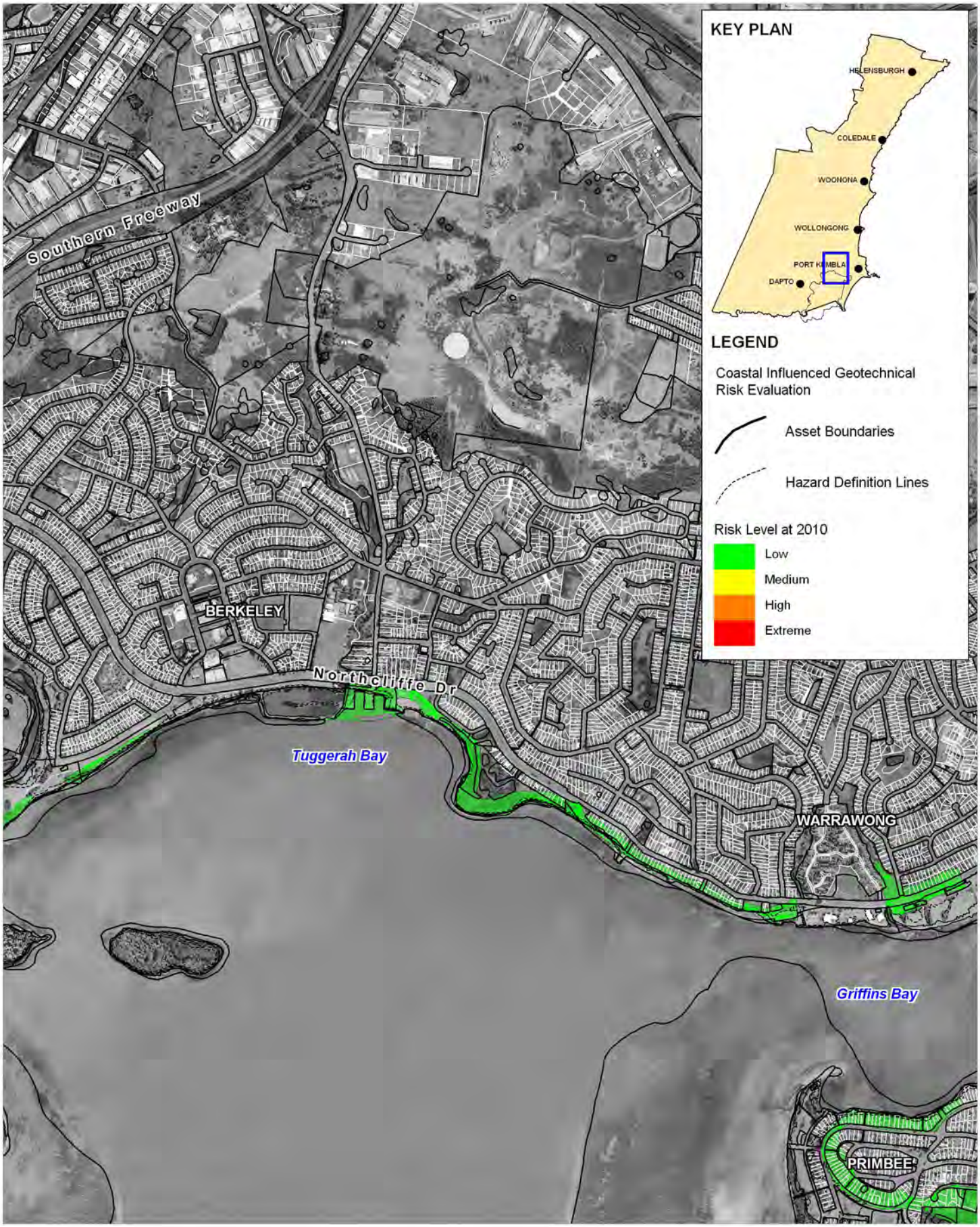
0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_251_110419 Drawing G-13.WOR



Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Berkeley/Warrawong

Drawing: G-14

Rev: A

N

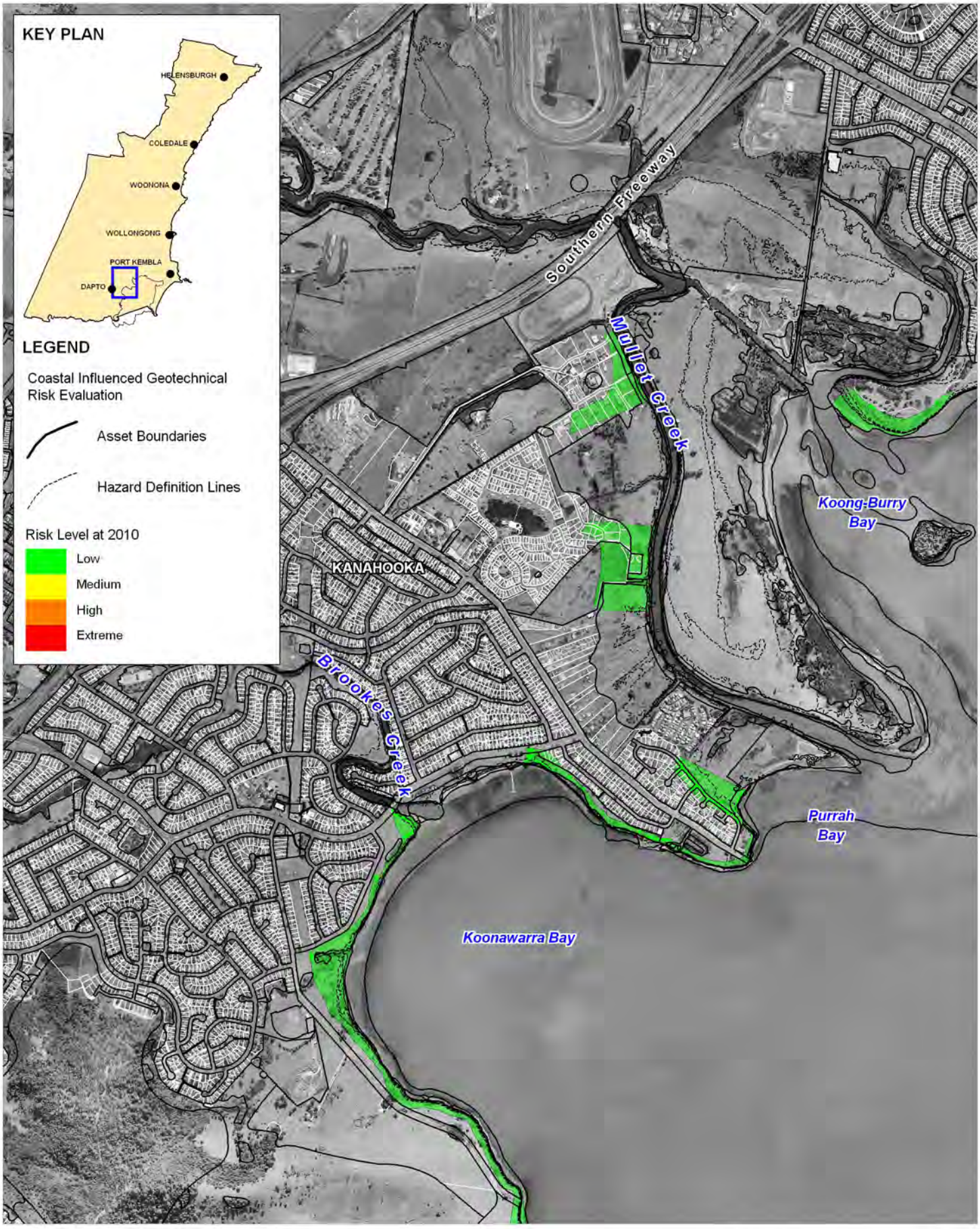
0 375 750m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_252_110420 Drawing G-14.WOR



Title:

Coastal Influenced Geotechnical Risk Evaluation
Immediate Planning Horizon - Kanahooka

Drawing: G-15

Rev: A

N

0 375 750m

Approx. Scale

BMT WBM

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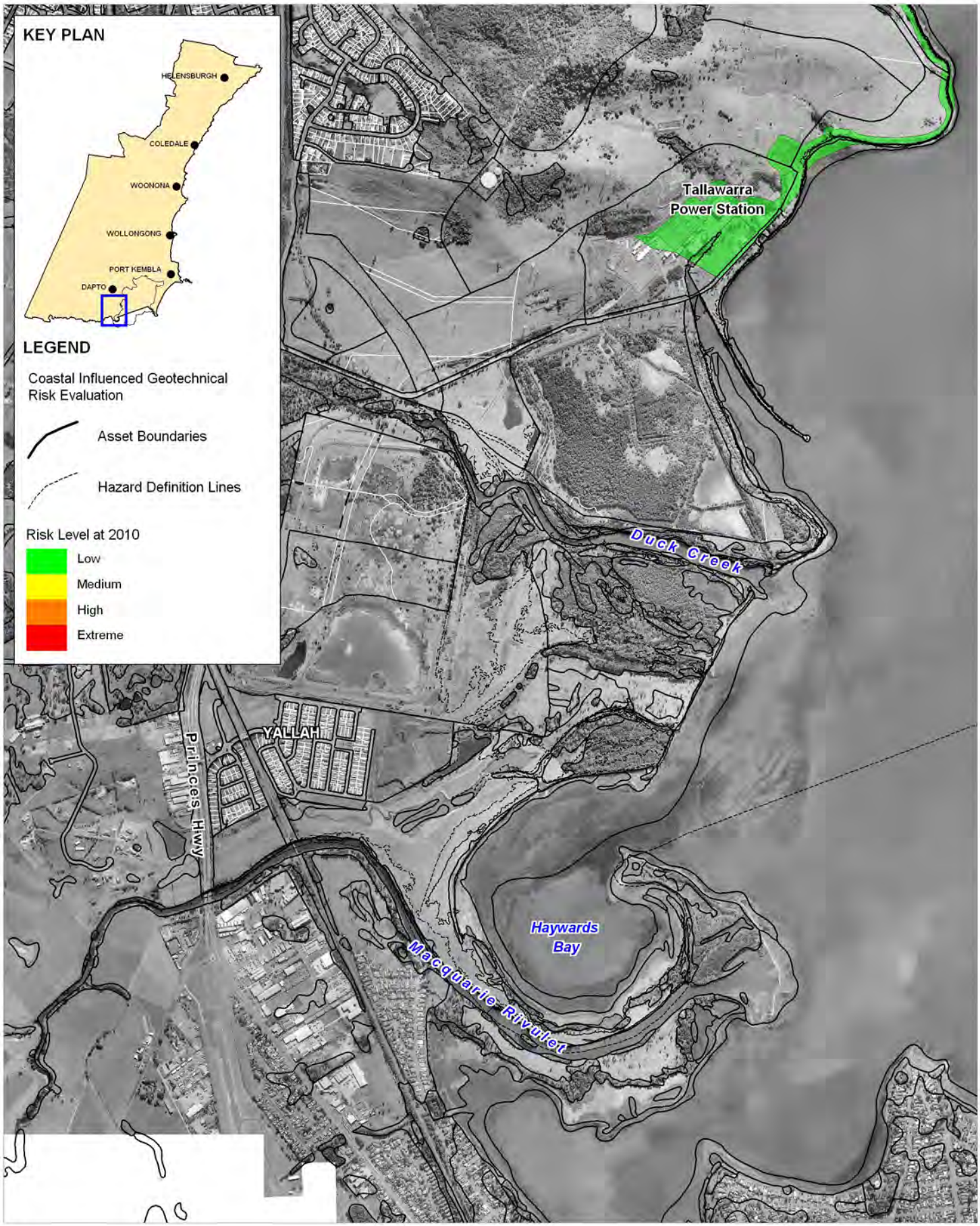

Title:

Coastal Influenced Geotechnical Risk Evaluation immediate Planning Horizon - Tallawarra

Drawing: G-16

Rev: A

N

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Approx. Scale

BMT WBM

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Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_254_110420 Drawing G-16.WOR

APPENDIX B: ESTUARY PLANS AND BEACH ACCESS ARRANGEMENTS

Estuary Management

Council has prepared two Estuary Management Plans for the 14 coastal creeks and lagoons for which it has management responsbilty. These Plans have been adopted by Council and are now in the implementation stage. They address the estuary health issues. Entrance Management Policies have also been prepared for Fairy and Towradgi lagoons and Council is in the process of preparing one for Bellambi Lagoon. The Estuary Management Plans and Entrance Management Policies are listed below:

- Estuary Management Study and Plan for Fairy, Towradgi, Hewitts/Tramway Creeks;
- Estuary Management Study and Plan for Several Wollongong Creeks and Lagoons;
- Entrance Management Policy for Fairy Lagoon; and
- Entrance Management Policy for Towradgi Lagoon.

Community Use and Beach Access Arrangements

Several Plans of Management (POMs) have been prepared, which guide the management of certain foreshore areas along the Wollongong coastline. These POMs are listed in Section 2.2.7.1 of the Management Study. In addition, Council has Dune Maintenance Program, through which beach access is maintained. Through a Beach Servcies Program, beach combing and lifeguard services are provded at several reaches. Beach access and amenity is therefore considered to be satisfactory at all beaches at the present time. The table below provides a summary of the beach access and amenity arrangements.

Beach	Access Road	Car Parking	Beach Access	Beach Patrol	Recycling Bin	Other Facilities
Stanwell Park	Yes	Yes	Dune Walkways	Yes	Yes	Surf Club, Kiosk
Coalcliff	Yes	Yes	Tracks	Yes		Surf Club, Rock Pool
Scarborough/ Wombarra	Yes	Yes	Tracks	Yes		Rock Pool
Coledale	Yes	Yes	Tracks	Yes		Surf Club, Rock Pool; Camping Ground
Austinmer	Yes	Yes	Tracks	Yes	Yes	Surf Club, Rock Pool, Seating
Thirroul	Yes	Yes	Tracks	Yes	Yes	Surf Club, Pool, Kiosk, Seating

Beach	Access Road	Car Parking	Beach Access	Beach Patrol	Recycling Bin	Other Facilities
Sandon Point	Yes	Yes	Dune Walkways	Yes		Surf Club
Bulli	Yes	Yes	Dune Walkways	Yes	Yes	Surf Club, Rock Pool, Kiosk, Cycleway, Seating
Woonona	Yes	Yes	Dune Walkways	Yes		Surf Club, Pool, Cycleway
Bellambi	Yes	Yes	Dune Walkways	Yes		Surf Club, Rock Pool, Cycleway
Corrimal	Yes	Yes	Dune Walkways	Yes		Surf Club, Cycleway
Towradgi	Yes	Yes	Dune Walkways	Yes		Surf Club, Rock Pool, Kiosk, Cycleway, Seating
Fairy Meadow	Yes	Yes	Dune Walkways	Yes		Surf Club, Cycleway
North Wollongong	Yes	Yes	Walkways	Yes		Surf Club, Pools, Kiosk, Cycleway, Seating
City	Yes	Yes	Dune Walkways	Yes	Yes	Surf Club, Kiosk, Cycleway, Seating
Port Kembla	Yes	Yes	Paths	Yes	Yes	Surf Club, Pools, Kiosk, Seating
Windang	Yes	Yes	Dune Walkways	Yes		Surf Club

APPENDIX C: LEGISLATION SUMMARY

Coastal Protection Act 1979

The NSW *Coastal Protection Act 1979* (the CPA Act) provides guidance on the use, occupation and development of the coastal zone in NSW. The CPA Act was amended in 2002 to better reflect the purpose of the NSW Coastal Policy (1997) and to incorporate the principles of ecologically sustainable development.

The objects of the CPA Act are to provide for the protection of the coastal environment of the State for the benefit of both present and future generations and, in particular:

- to protect, enhance, maintain and restore the environment of the coastal region, its associated ecosystems, ecological processes and biological diversity, and its water quality;
- to encourage, promote and secure the orderly and balanced utilisation and conservation of the coastal region and its natural and man-made resources, having regard to the principles of ecologically sustainable development;
- to recognise and foster the significant social and economic benefits to the State that result from a sustainable coastal environment, including
- benefits to the environment, and
- benefits to urban communities, fisheries, industry and recreation, and
- benefits to culture and heritage, and
- benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water;
- to promote public pedestrian access to the coastal region and recognise the public's right to access;
- to provide for the acquisition of land in the coastal region to promote the protection, enhancement, maintenance and restoration of the environment of the coastal region;
- to recognise the role of the community, as a partner with government, in resolving issues relating to the protection of the coastal environment; and
- to ensure co-ordination of the policies and activities of the Government and public authorities relating to the coastal region and to facilitate the proper integration of their management activities.

The Act allows the Minister for the Environment to direct a council with land within the coastal zone to prepare a Coastal Zone Management Plan, and gives directions as to how such Plans shall be prepared, approved, gazetted and amended where necessary.The Act also requires Coastal Zone Management Plans to incorporate provisions for emergency beach erosion management and to provide for the unobstructed access to the coastline (beaches, headlands, waterways) by the public.

Changes to the act as part of the *Coastal Protection and Other Legislation Amendment Act* are outlined below.

Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EPA Act) is the key NSW legislation for planning and land use. The Act provides a system of environmental planning and assessment for NSW, and involves developing plans to regulate competing land uses, through 'environmental planning instruments'.

The EPA Act establishes three types of environment planning instruments (EPI):

- Local Environmental Plans;
- Regional Environmental Plans; and
- State Environmental Planning Policies.

The objectives of the EPA Act are to encourage:

- proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment;
- promotion and co-ordination of the orderly and economic use and development of land;
- protection, provision and co-ordination of communication and utility services;
- provision of land for public purposes;
- provision and co-ordination of community services and facilities;
- protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats;
- ecologically sustainable development;
- the provision and maintenance of affordable housing;
- promotion of the sharing of the responsibility for environmental planning between the different levels of government in the State;
- provision of increased opportunity for public involvement and participation in environmental planning and assessment.

Approval processes for "development" and "works" in NSW are provided for in Part 3A, Part 4, Part 5 and Part 5A of the EPA Act. Key provisions are outlined briefly below.

Part 3A – Major Infrastructure and Other Projects (now repealed)

Part 3A came into operation in August 2005 and applies to development that is declared to be a project to which the part applies. A project can be declared by:

- A State Environmental Planning Policy (SEPP), with SEPP No. 71 – Coastal Protection of relevance to the coastal zone, or
- By order of the Minister for Planning published in the Government Gazette.

There are two types of development that may be declared for Part 3A approval (i.e. in addition to those directed to the Minister via a SEPP):

- Major infrastructure or other development that in the opinion of the Minister is of state or regional environmental significance, or
- Old Part 5 activity approvals where the proponent is the determining authority and an EIS would have been required.

Guidelines regarding Part 3A projects have been provided by the Department of Planning.

Part 4 – Development Assessment

Part 4 of the EPA Act lays out the legislative regime for the standard process for lodgement and consideration of development applications. Part 4 processes essentially apply where the local authority (Council) is the consent authority. The majority of land based development within the Wollongong study area will fall within Part 4 of the EPA Act.

The controls and permissibility for development of particular sites and / or uses are found in the Wollongong Local Environment Plan (LEP) and Wollongong Development Control Plan (DCP) (see Section **Error! Reference source not found.**).

Part 5 – Environmental Assessment

Part 5 outlines the requirements for determining authorities to consider the environmental impact of activities, through an environmental assessment for the proposed activity. The environmental assessment shall outline the effect of the activity on critical habitat, endangered fauna, vulnerable species, conservation agreements (under the *National Parks and Wildlife Act 1974*), plans of management, wilderness areas (under the *Wilderness Act 1987*) and joint management agreements and bio-banking agreements under the *Threatened Species Act, 1995*, and any other legislation pertaining to the proposed activity.

Part 5 of the Act applies to proposed activities that are permissible without development consent under Part 4 of the EPA Act but require approval from a Minister or Public Authority, or is proposed to be carried out by a Minister or Public Authority (and Council is classified as a Public Authority).

Part 5 obliges the "determining authority" for the proposal to consider the environmental impact of any activity. A determining authority is the public authority which is required to approve an activity, and can also be the public authority proposing to carry out the activity. For example, Council is permitted to undertake certain environmental management activities under SEPP (Infrastructure) 2007 without development consent, however may need to complete and environmental assessment under Part 5 of the EPA Act.

Part 5A (Development by the Crown) essentially provides a legislative regime for consideration of Development Applications made by, or for and on behalf of, the Crown.

The remaining parts of the EPA Act relate to: Part 6 – Implementation and Enforcement; Part 7 – Finance and Part 8 – Miscellaneous.

Crown Lands Act 1989

The *Crown Lands Act 1989* (the CL Act) provides for the administration and management of Crown land for the benefit of the people of NSW. The CL Act provides principles for the proper assessment, development, reservation or dedication and conservation of Crown Lands.

Waterbodies such as beaches and foreshores and estuaries / creeks / lagoons to the mean high water mark are designated as Crown Land. The lands below MHW are managed by the Department of Industry – Lands & Forestry.

In addition to this, there are many other parcels of land within the Wollongong coastal zone that are Crown reserves that are controlled and managed by Council (that is, Council is the Wollongong City Council (WCC) is the reserve trust manager or trustee appointed by the Minister for Lands to care, control and manage the land in accordance with its public purpose). These Crown reserves must be managed in accordance with the public purposes of the land and the principles as set out in Section 11 of the *Crown Lands Act 1989*.

The principles of Crown Land management as defined in Section 11 of the Act are: environmental protection principles be observed in relation to the management and administration of Crown land; natural resources of Crown Land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible; public use and enjoyment of Crown lands be encouraged; where appropriate, multiple uses of Crown land be encouraged; and where appropriate, Crown Land be used and managed in such a manner that the land and its resources are sustained in perpetuity.

In addition to these principles, the objectives of the Coastal Crown Lands Policy 1991 apply to Crown lands within the coastal zone of Wollongong. The policy sets specific objectives for conserving the environmental and cultural qualities of coastal Crown Land, retaining in public ownership coastal lands that are environmentally sensitive and / or required for public purpose, and providing use of coastal crown lands for recreation, tourism, residential and commercial development with due regard to the nature and consequences of coastal processes.

A Plan of Management (POM) should be prepared for Crown land reserves to identify the key attributes and values of the area, general physical improvements to enhance the values and to specify the permissible uses for the land. Division 6 of the Act discusses the preparation and adoption of POMs by the reserve trust and the Minister. Plans of Management relating to Council managed Crown lands in Wollongong are discussed below in relation to the *Local Government Act 1993*.

Local Government Act 1993

The *Local Government Act 1993* (the LG Act) creates local governments and grants them the power to perform their functions, which involve management, development, protection, restoration, enhancement and conservation of the environment for the local government area. The functions of the local government are to be performed in a manner that are consistent with and promote the principles of ecologically sustainable development.

The service functions of local councils are defined in Chapter 6 of the LM Act. The service functions of councils relate to the classification, use and management of public land, including the objectives for management of the community land owned by Council (i.e. that is not Crown Land). Section 35 of the

act provides that community land only be used in accordance with the plan of management applying to the parcel of community land; any law permitting the use of the land for a specified purpose or otherwise regulating the use of the land; and the provisions of Division 2 Chapeter 6 of the Act. Community land can be categorised into a range of categories under Section 36 of the act, and each of these categories have their own core objectives specified under the Act. The categorisation of community lands is important as the Act requires Council to only grant a lease, licence or another estate (other than in respect of public utilities) for a purpose consistent with the core objectives of the category of that community land.

Council has a generic plan of management (POM) and a range of site specific POMs that govern the permissible uses for Community Land (both Council owned land and Council managed Crown Lands). The relevant POMs for coastal Community Lands include:

- Stanwell Park Reserve and Bald Hill Plan of Management August 2009
- Wollongong City Foreshore Plan of Management, January 2008
- Coledale Beach Plan of Management, June 2004
- Judbooley Parade, Windang Plan of Management, June 2008
- The Community Land of Wollongong Generic Plan of Management 2010

There are also other POMs that relate to Andrew Lysaght Park (December, 2002), City Beach (July, 2001 and December 1995), North Beach and Stuart Park (August, 2000), and these areas are now largely covered within the Wollongong City Foreshore POM. The Blue Mile MasterPlan provides more detail regarding the improvements proposed within the Wollongong City Foreshore POM, outlining the series of improvements and actions proposed in the Wollongong City Foreshore POM area.

A review of these POMs indicated that only the Coledale Beach Reserve POM provided a strategy directly relating to the incorporation of coastal hazards in future planning. The strategy requires new development and activities to be located behind the 50 year hazard line and structural protection to protect existing assets seaward of the 50 year hazard line (although, the type of structural protection, or any costs or benefits to structural protection was not indicated). In contrast, the other POMs, particularly the Blue Mile Master Plan (supported by the Wollongong City Foreshore POM), provide for a range of improvements to community facilities, but did not specify that planning for coastal erosion or other hazards be incorporated into the improvement works. The proposed improvements included:

- Replacement of the seawall at North Beach, although the length of this wall (or coastal engineering requirements) was not indicated
- The relocation of the North Beach SLSC, although the proposed location also lies within the 2100 year hazard extent, however designing to accommodate recession and inundation was not noted
- The refurbishment of the North Beach pavilion, again without notation for improving resilience to storm waves and water levels
- Improving access to the northern breakwater of the harbour, without notation for incorporating raising of the breakwater as part of access improvements, that would provide for sea level rise,

- Improving and widening the cycleway and shared pathways from North Beach through Brighton Lawn Reserve to City Beach, again without noting the opportunity to improve the path's resilience to coastal erosion.

While the various POMs provide suitable guidance for use and enjoyment of Community Lands, there is little provision for incorporating improvements of these lands with improving the resilience to coastal hazard impacts.

The Now Revoked NSW Sea Level Rise Policy Statement (2009)

The NSW (2009) Sea Level Rise Policy Statement (the Policy Statement) sets the planning standards for projected sea level rise over the next century that are to be adopted in all forms of coastal assessment, from development applications to coastal hazards definitions studies and coastal zone management plans.

The NSW Government has adopted benchmarks of 0.4 m rise in sea level by 2050 and 0.9 m by 2100 as the best national and international projections for the NSW Coast (at the present time). These benchmarks were used to prepare the Wollongong Coastal Zone Study and hazard lines.

The Policy Statement also provides guidance on the risk-based assessment approach recommended by the NSW Government, and the support the state intends to provide to coastal communities to prepare and adapt to the medium to long term social, economic and environmental impacts of sea level rise.

The NSW Government intends to support local councils through funding assistance for voluntarily purchasing of property or for protection works, provided such actions are based upon thorough assessments (such as a CZMP) that outline the magnitude of the hazard risk, cost-effectiveness of the action including maintenance costs, ability to adequately protect from sea level rise, and the genuine hardship of coastal residents and benefiting landholders. The NSW Government has stated a commitment to:

- promoting risk-based assessment approaches to sea level rise and coastal planning;
- providing guidance to councils to support adaptation planning initiatives;
- encouraging appropriate development on land at risk from sea level rise;
- providing continued emergency management support for damaging storms and floods; and
- providing ongoing updated information to the public about sea level rise and projected impacts.

The Sea Level Rise Policy Statement (2009) supersedes the 1988 Coastline Hazards Policy with respect to managing sea level rise. The Policy Statement is to be used in conjunction with the existing legislation and policies for coastal management.

Although the NSW standard sea level rise benchmarks are now revoked, Wollongong City Council resolved to continue to use the same benchmarks for its planning and development decisions.

State Environmental Planning Policy No. 71 – Coastal Protection

State Environmental Planning Policy No. 71 – Coastal Protection (SEPP71) aims to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast. SEPP 71 aims for development in the NSW coastal zone to be appropriate and suitably located, in accordance with the principles of the Ecologically Sustainable Development (ESD). SEPP 71 applies to all lands within the coastal zone of NSW, which is defined on gazetted maps under the SEPP.

The policy provides for: the protection of and improvement to public access compatible with the natural attributes coastal foreshores; and protects and preserves Aboriginal cultural heritage, visual amenities of the coast, the beach environment and amenity, native coastal vegetation, marine environment of New South Wales, and rocky platforms.

SEPP 71 also outlines the conditions for which the Minister for Planning becomes the consent authority for 'significant coastal development'. SEPP 71 defines this as development in 'sensitive coastal locations' namely land within 100 metres of and below mean high water mark of the sea, a bay or an estuary. Development applications received by Council on such lands must be sent to the Director-General of Planning, and Council is required to take the 'matters for consideration' given in Clause 8 of SEPP 71 and any additional matters specified by the Director-General into account when determining the application.

A master plan is required to be submitted and adopted by Minister for Planning (prior to Council granting consent) for subdivision of land within a residential zone or rural residential zone if part or all of the land is in a 'sensitive coastal location'. This would apply to any future subdivision of land in the Study area.

SEPP 71 does not apply to land within the Wollongong city centre.

The NSW Coastal Planning Guideline: Adapting to Sea Level Rise

The NSW Coastal Planning Guideline: Adapting to Sea Level Rise (the Planning Guideline), support the SLR Policy Statement and were finalised by Department of Planning (DP) in August 2010. The Planning Guideline describes how sea level rise should be considered in land use planning and development assessments. The Planning Guideline outlines six coastal planning principles for adapting to climate change, including:

- assessing and evaluating the coastal risks taking into account the sea level rise benchmarks set by the NSW Government (refer the Policy Statement);
- advising the public as to coastal risks to facilitate informed land use planning and development decision making;
- avoiding the intensification of land use in coastal risk areas through appropriate strategic and land use planning;
- considering options to reduce the intensity of land use in coastal risk areas;
- minimising exposure of development to coastal risks; and

- implementing appropriate management responses and adaptation strategies that consider the environmental, social and economic impacts of such responses.

In evaluating coastal risk areas, the Planning Guideline defers to the former DECCW (2010), now OEH (2010) Coastal Risk Management Guideline (see discussion below). The coastal risk areas should be identified through specific local studies, at which point they should be mapped in LEPs, regardless of current land zoning.

The Planning Guideline advises that strategic land use planning shall discourage intensification of development in coastal risk areas. For example, changing land use from rural to urban or increasing housing density shall be avoided in high risk areas due to the potential future risk to life, property and the environment. As changes to land use may affect the future development potential of an area, the Guideline recommends these changes be applicable to the level of risk. Where possible, new coastal subdivisions and urban developments shall be located outside the 2100 coastal risk area.

The Guideline makes reference to the *Coastal Design Guidelines for NSW* (2003) for strategic land use planning (height, scale and setback), retaining foreshores and headlands in public ownership and protecting from storm events and sea level rise.

Coastal Risk Management Guide – Incorporating sea level rise benchmarks in coastal hazards assessments

The Coastal Risk Management Guide – Incorporating sea level rise benchmarks in coastal hazards assessments (DECCW, 2010) states that the identified risk area for coastal planning is to include the existing coastal hazards region plus an additional area affected by sea level rise. DECCW (2010) suggests coastal hazards studies should assess a coastal hazard planning line both with and without sea level rise (at benchmark levels set by the Policy Statement).

The guideline also indicates that the defined coastal inundation hazard should include sea level rise to benchmark levels as part of the assessment, and Design Still Water Levels to be used in such assessments are provided. This Guide was used to prepare the beach erosion and recession and coastal inundation hazard extents in the Wollongong Coastal Zone Study (Cardno, 2010).

The CZMP Guidelines will replace this Guide once adopted by the Minister.

Coastal Protection and Other Legislation Amendment Act 2010

NSW Government's reforms to coastal erosion management were facilitated through the Coastal Protection and Other Legislation Amendment Act 2010 resulting in amendments to the *Coastal Protection Act 1979*, the *Local Government Act 1993* and *Environmental Planning and Assessment Act 1979*. The amendments were passed in October 2010, and came into effect in January 2011. Key amendments are as follows.

- The amendments outline emergency coastal protection works that landholders or public authorities (Council) are permitted to carry out under Part 4C of the *Coastal Protection Act*. The emergency coastal protection works must be consistent with a Code of Practise associated with this Part, which includes the authorised locations for these works, the trigger for their implementation, length of time they are permitted, form of the works (i.e. no higher than 1.5 m AHD, using sand and sand bags placed at toe of erosion scarp only, and only using imported

sand), and . There are no authorised locations in the Wollongong LGA. Additional amendments to Part 4C of the *Coastal Protection Act* in 2012 have modified the allowances for such works (now named 'temporary protection works'; see below for details).

- Improved order powers for Council officers to order the removal or fine landholders who have placed inappropriate protection works (temporary or otherwise) on public or private land was outlined, including 'stop work' orders, increased penalties for such illegal actions, and exemptions from liability for Council officers who place the orders (Section 4D of the *Coastal Proection Act 1979*).
- Amendments to enable Council to levy an annual coastal protection service charge to landholders under Section 55B of the *Local Government Act 1993* who have funded or part-funded coastal protection works (such as seawalls), to pay for ongoing maintenance of the works and management of offsite impacts were implemented.
- Legislative amendments were made that permit landholders to submit applications to erect long term coastal protection works, with approval contingent on the landholders demonstrating that potential offsite impacts can be managed, including ongoing works such as beach nourishment, refer Section 55M of the *Coastal Protection Act 1979*. The works can be fully funded by the landholders who submit the application. Ongoing maintenance can be facilitated through annual coastal protection service charge (as above).
- A joint state-local body called the NSW Coastal Panel was established under Part 2A of the *Coastal Protection Act 1979* to act as a consent authority for proposed long term protection works (e.g. as above) where a council does not have an adopted CZMP and / or requires further technical assistance in assessing such development applications, and to assist the Minister when requested, such as for reviewing CZMPs.

Coastal Protection Amendment Act 2012

This act permitted modifications to Part 4C of the *Coastal Protection Act 1979* relating to coastal protection works. The key change was renaming such works from 'emergency' to 'temporary' protection works, to enable authorised landholders to erect such works regardless of the impending occurrence of a storm, in response to coastal erosion. The works are not permitted on estuarine foreshores.

A Code of Practise is associated with the placement of temporary coastal protection works, revised in 2013. The Code of Practise outlines the height, materials and form for the placement of temporary coastal protection works, and the procedure for removal and remediation of such works. The Code of Practise contains a Schedule listing those locations at which temporary works are authorised. It is assumed that temporary works are not permitted at locations not listed in the Schedule.

The Amendment Act 2012 also simplified the process for landholders to gain approval to erect such works. Private landowners are now permitted to place temporary coastal protection works on their land without approval or a certificate from the local council or state government. Private landowners are also permitted to place these works on public land, provided they obtain a certificate for these works, and may keep such works in place for up to 2 years.

The fines for inappropriate placement of sand or sandbags (such as associated with the erection of temporary coastal protection works) have been halved, to reflect the lesser nature of such incidences.

The heavy fines for placement of other non-beach materials (e.g. rocks, car bodies, bricks etc.) remain as per the 2010 CP Act amendments.

OEH or Councils (if they have authorised officers for this task) may order the removal of the temporary protection works where it is evident that such works are having detrimental impacts upon adjacent land or on beach amenity.

Coastal Protection Service Charge Guidelines

Also in December 2010 the former DECCW published the Coastal Protection Service Charge Guidelines which outlines the Coastal protection Service Charge, described as a service to maintain and repair coastal protection works or to manage the impacts of coastal protection works. The guidelines detail how it can be used to fund the protection of private property by those property owners deemed to benefit from the works and describing how the amount of the rate should be calculated over the design life of the works. The Minister for Climate Change and the Environment published a notice in the Government Gazette on 31 December 2010 that he had issued these guidelines for the purposes of the Local Government Act.

Eligible coastal protection works for the CPSC include:

- works voluntarily constructed by a benefiting landowner (or landowners)
- works constructed jointly by a public authority (e.g. council) with voluntary contributions from benefiting landowners
- works that existed before section 496B of the Local Government Act 1993 commenced, where the landowner or a previous landowner voluntarily agreed to pay the CPSC
- works that existed before section 496B of the Local Government Act 1993 commenced, where the landowner has voluntarily agreed to upgrade the works. A pro-rata CPSC then applies, based on the incremental additional costs of maintaining the works and managing their off-site impacts.

Residents must agree to pay the CPSC prior to the works being constructed. This annual charge is then attached to the land and becomes the responsibility of all future land owners for the life of the protection works. The amount of the charge is regularly reviewed depending on the cost of maintaining the works and in ameliorating any adverse impacts. Where works are implemented by Council and Council chooses to contribute to the cost of the works then Council also must accept liability for a portion of the future CPSC.

SEPP (Infrastructure) 2007

SEPP (Infrastructure) 2007 provides a consistent planning regime for infrastructure and the provision of services across NSW, including consultation with relevant public authorities during the assessment process. The intent of the SEPP is to support greater flexibility in the location of infrastructure and service facilities along with improved regulatory certainty and efficiency for the State.

The SEPP also relates to 'waterway or foreshore management activities' (Division 25) which are defined as:

'(a) riparian corridor and bank management, including erosion control, bank stabilisation, resnagging, weed management, revegetation and the creation of foreshore access ways, and

(b) instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes, and

(c) coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways.'

Section 129 of the SEPP states that development for the purposes of waterway or foreshore management activities (such as defined above) may be carried out by or on behalf of a public authority (i.e. Council) without consent on any land. Such activities include:

- construction works;
- routine maintenance works;
- emergency works, including works required as a result of flooding, storms or coastal erosion;
- environmental management works.

Thus in the study area, Council is permitted to undertake foreshore management (such as a revetment walls, beach nourishment environmental rehabilitation etc), provided they undertake a Review of Environmental Factors (REF) (under Part 5 of the EPA Act), and any other relevant approvals required relating to the land (e.g. *Crown Lands Act 1989*, *Fisheries Management Act 1994*, *Water Management Act 2000* etc).

SEPP (Infrastructure) 2007 repealed SEPP 35 Maintenance Dredging of Tidal Waterways. Further, changes to SEPP Infrastructure are proposed to permit landholders to construct seawalls, as outlined in the the *Coastal Protection and Other Legislation Amendment Bill 2010.*

Coastline Hazard Policy 1988

The NSW Government's Coastline Hazard Policy (1988) aims to reduce the impact of coastal hazards upon land owners and occupiers in the coastal zone, and to reduce public and private losses which may result from coastal hazards. With respect to sea level rise, the 2009 NSW Sea Level Rise Policy Statement supersedes this policy. The remaining objectives from that policy are incorporated into the NSW Coastal Policy 1997.

Coastline Management Manual (1990)

The Coastline Management Manual (1990) documented the NSW Government's Coastline Hazard Policy (1988) and provided guidance for undertaking the required Coastal Hazards Definition studies, Coastline Management Studies, and the preparation of Coastline Management Plans. This document was the guideline document for the Wollongong City Council Coastal Zone Study (Cardno, 2010) (Wollongong Coastal Zone Study).

OEH (formerly DECCW) adopted the *Guidelines for Preparing Coastal Zone Management Plans* in December 2010 which replace the Coastline Management Manual (and other documents).

APPENDIX D: SUMMARY OF APPROACH TO ASSESSING BEACH EROSION

The SBEACH modelling package calculates cross-shore sediment transport under storm waves and water levels to determine erosion from the beach and dunes during a storm event. The model assumes fine to medium grained sands, and rock layers can be specified within the cross-shore profile used in the model. Geotechnical surveys were conducted at most of the study area beaches, to determine the presence or otherwise of rock layers and sediment grain size data, which was incorporated into the SBEACH model for storm demand analyses, to provide better certainty to the model results.

A key limitation of SBEACH is that it does not include longshore sediment transport, and thus cannot account for the movement of sediment along a beach that may enhance or reduce erosion at any one cross shore profile. SBEACH also does not include rip cell circulation and erosion.

In order to investigate beach erosion, a single design storm condition was adopted by Cardno (2010). The 'design' storm event analysed at Wollongong used the peak 100 year ARI offshore wave height (of 10.6 m H_s) calculated from wave data from Botany Bay over the 1971 to 1985 period (Cardno, 2010). This period of wave data was analysed because it covers the stormiest wave period on record, therefore providing a conservative the 'design' storm wave height for investigation.

Based upon the directional wave data from Sydney, storm waves are expected to originate from the east-south-east to south sector (Cardno, 2010). The critical offshore wave direction, as determined from the nearshore wave modelling was found to be ESE at Wollongong's beaches (the critical offshore wave direction was defined by Cardno (2010) as the offshore wave direction that leads to the largest nearshore wave height, for a specified offshore wave height).

Based upon the nearshore wave modelling, wave heights at the 6 m contour at each beach profile to be modelled in SBEACH was output for the 100 year ARI wave height (presumably for the critical offshore wave direction of ESE).

However, it should be noted that the greatest extents of beach erosion recorded have been in response to a series of closely spaced storms, rather than a single storm, most notably, the series of storms during 1974, particularly May – June. Care is thus required in interpreting storm demand estimates from a single storm event for planning purposes.

Photogrammetric data provides the only available data on change in beach volumes and width overtime. Aerial photographs are analysed in stereo to calculate ground elevations. The use of historical aerial photographs can therefore provide a snapshot of beach volume at that time. The data can provide insight into the response of the beach to storm events, and potential trends in beach volume change over time, for example, long term recession. However, given the large times (years) between dates compared with the varying timescales of beach systems (hours to thousands of years) care must be taken to interpret the photogrammetric data, particularly to recognise inaccuracies and anomalies from long term trends.

Photogrammetric data was available from ten of Wollongong's beaches, namely Austinmer, Thirroul, Coledale, Sandon Point, Bulli, Woonona, Corrimal, North Wollongong, Coniston and Perkins. The data sets variously captured dates between 1936 and 2007, with between four and twelve dates for each beach. At almost all beaches, the 1974 photogrammetric profiles demonstrated the most eroded beach position. Since this time, the photogrammetric data indicated a steady increase in beach volumes to the latest date in 2007 (Cardno, 2010).

Photogrammetric data was processed to determine the largest volume difference between consecutive photogrammetric dates. This was said to provide an indirect estimate of the erosion due to large storm events. Within individual beaches, volume losses between consecutive dates were averaged across all profiles within that beach, to provide a single average value for that beach. It should be noted that this may significantly underestimate the potential erosion at any one location along a beach. For planning future development, the average beach profile volumetric loss will be less than the potential hazard to back beach development relating to both rip cells and longshore sediment transport within an embayment (often termed beach rotation). The photogrammetric data can capture rip cell erosion, which cannot be modelled and which is typically much greater than the average erosion along a beach.

The SBEACH modelling was completed for 2 – 4 profiles on each beach (depending on the length of the beach). The "average" beach profile (i.e. the average beach position from all dates of photogrammetry) at each beach with photogrammetric data, or the current beach profile from ALS data was used as the starting profile for the SBEACH modelling, and to measure the beach erosion hazard adopted. The 'design' storm were modelled over a 7-days storm event (as described by Carley and Cox, 2003, where the wave height and water level increases to its peak at the middle of the 7 day period, then dissipates).

SBEACH model results at each beach were then scaled up based on the scaling of Bulli Beach to the 'high' storm demand estimate of 250 m^3/m.

The volumetric losses given in the photogrammetric data for some beaches were greater than both the modelled and scaled storm demand values adopted (e.g. measured 'average' volume loss of 206 m^3/m compared with an adopted 147 m^3/m at central Woonona Beach). This is likely because the photogrammetric volumes were calculated from consecutive dates of photogrammetry that were too widely spaced (> 2 years) to be representative of the single 'design' storm. The widely spaced dates of photogrammetry do not represent a 'design' storm, but do indicate the envelope of beach erosion-accretion cycles that may occur. Therefore, it is possible that the storm demand estimates adopted for each beach will be exceeded, particularly in relation to consecutive storms over longer (decadal) periods.

The potential change in storm erosion due to climate change was not explicitly investigated (Cardno, 2010), as the current climate change projections are inconclusive. In the present climate, long period (inter-annual to inter-decadal) oscillations in climate occur, such as the ENSO phenomenon which is documented to modify the frequency of east coast low events. Current evidence suggests east coast lows can occur twice as often during La Nina compared with El Nino climate cycles (Verdon, et al, 2004). These variable climatic processes affect wave conditions such that it can be expected there will be periods of relatively enhanced storminess over years to decades, such as was reported during the 1970s. Cardno (2010) attempted to include the 1970s period of enhanced storminess by adopting the peak offshore wave height of 100 yr ARI from measured wave data over 1971 to 1985. However,

the SBEACH modelling of Cardno (2010) did not account for consecutive storms, which are known to have produced the enhanced erosion measured on NSW beaches during the 1970s. Therefore, it is possible that the SBEACH storm demand values adopted for the beach erosion hazard at Wollongong may be exceeded.

An erosion hazard or recession hazard (due to sea level rise) was not defined for the Lake Illawarra foreshore. This was because the very low wave energy within the lake was thought to result in episodic but small erosion events at the shoreline. While it is expected that the lake foreshores shall also recede in response to a rise in sea level, Cardno (2010) again this was assumed to be small.

APPENDIX E: BEACH ASSET CONSEQUENCE TABLES

Stanwell Park Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Stanwell Park Beach	Major	Insignificant		Beach and adjacent parkland is regionally recognised, has iconic status as a day trip destination, with many day visitors from Sydney.			
Stanwell Park Recreation Area Park	Moderate	Minor		Area is used as a hang-gliding landing area and parking and pack up area. Area has been used by the Stanwell Park Hang Gliding & Paragliding Club (SPHGPC) for many years. They lodged DA in 2002 (still in negotiation in 2009) to use the reserve and Bald Hill sites for this purpose. POM states intent to provide a Lease / Licence to the SPHGPC for hang gliding and paragliding activities carried out in accordance with the DA consent up to 10 years. Consequence for this park is major as area used extensively for hangliding, with oldest club. The park land is associated with regional recognition of beach, with regular visitors and users both from the northern LGA and Sydney. It is also the only sandy beach between Coalcliff and the more inaccessible beaches in Royal National Park.	Stanwell Park / Bald Hill POM	Update POM to enable use of other park sections, as required due to inundation / erosion impacts	
Coastal Dune Systems	Major	Insignificant		Beach and dunal regions are identified as a High Priority site for restoration works.	Illawarra Biodiversity Strategy 2010 (Draft)*	Dune restoration as consistent with biodiversity strategy	
Hargraves Creek	Moderate	Minor		Creek has good structural complexity in estuarine vegetation communities, and does support some Saltmarsh EEC (GHD, 2007a). Creek is said to provide good potential foraging habitat for amphibians, microchiropteran bats, terrestrial and coastal birds, and birds of prey (GHD, 2007a). Periodic inundation may be beneficial for estuarine habitats and species.	Council staff		
Stanwell Creek	Moderate	Minor		Stanwell Park lagoon area is said to be a significant Aboriginal area. The estuarine reaches of Stanwell Creek provide good potential habitat for amphibians, microchiropteran bats, and birds (GHD, 2007a). Structural complexity is moderate, and a number or estuarine vegetation communities are supported including Saltmarsh EEC and Swamp Oak Forest EEC (GHD, 2007a). Periodic inundation may be beneficial for estuarine habitats/species.	Council staff / LALC		
Community Infrastructure							
Helensburgh / Stanwell Park SLSC	Major	Moderate	Major	Desire to increase footprint of SLSC, no plans to move (see POM notes) Currently operate out of this building (not separate tower) = need to retain line of sight Storage facility was intended / has been built (recommended in POM) POM noted "The surf club building is significantly constrained by bushfire threat, coastal hazards, a protected tree to the west and its proximity to the boundary of the adjoining privately owned property to the east". The POM indicates that the SLSC could be altered or expanded to improve usefulness for SLSC. Future expansion / alteration only possible within these contraints, and as suitable to character of Stanwell Park / Bald Hill	Council staff / Stanwell Park Bald Hill POM	Consider accommodate or relocate options in more detail	B02030

Stanwell Park Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Stanwell Park SLSC Storage Shed			Minor				B03455
Stanwell Park Beach Toilets (South)		Insignificant		Consequence value assumes damage/spills from the sewerage system would not occur during periodic inundation. Unknown if inundation levels may affect sewerage systems in this location			B02006
Kiosk (in Stanwell Park Recreation Area)		Moderate	Moderate	Plans for expansion and refurbishing, possible knockdown and rebuild. Assessing structure at present (to compare with cost of knockdown and rebuild). Structure is currently on ground. Consider possibility of raising structure (if choose not to knockdown and rebuild) The kiosk has a private residence (leased out, typically to manager of kiosk, not a caretaker). No reported inundation at this building in last 40 years Building is in good repair. Asset provides a valuable community resource, particularly for the northern section of the LGA and visitors from Sydney, as it is only sandy beach between Coalcliff and the more inaccessible beaches in Royal National Park.	Council Staff	Ensure re-design of Kiosk accounts for coastal processes and sea level rise (inundation)	B02240
Stanwell Park Reserve Dwelling		Moderate		Building is currently rented out as part of Kiosk facility, as noted above.			B02559
Stanwell Park Reserve Toilets		Minor	Minor				B02241
Transport Infrastructure							
Local Roads, (including car parks)	Minor	Moderate	Minor	Main access to beach for cars is unaffected by erosion.			
Water and sewage infrastructure							
Stormwater outlets and pipes		Major	Major	Area is steep sided, requires suitable infrastructure			
Residential Development							
Existing Residences (4 ppty S end, 1 centre of beach)	Moderate						
Vacant Land (Future Development) (1 blocks)	Minor					Setting development controls or preclude future development	
Existing Residences (7 ppty S end, edge of 1 centre of beach, edge of 9 ppties at end of creek)		Moderate		No flood study completed for Hargraves or Stanwell Creeks as yet, therefore the inundation levels are the first pass. Residents etc will not have been subject to flood controls (or Section 149) previously. Guidance and education required.			
Vacant Land (Future Development) (3 blocks)		Insignificant				as above	
Existing Residences (19 ppty S end, 2 centre of beach)			Moderate				
Vacant Land (Future Development) (1 blocks)			Insignificant			as above	

Coalcliff	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Coalcliff Beach	Major	Insignificant	Major				
Coalcliff Beach Reserve Nature Area, Coalcliff Beach Reserve	Minor	Insignificant		This area provides a buffer for recession of the beach amenity as there are little to no backing dunes, while still providing habitat value.			
Leeder Park		Minor	Minor	Park contains a childrens playground, likely to be one of few for the area, and access through to Coalcliff pool.			
Stoney Creek	Minor	Minor		Rocky creek relatively steep before flowing to a limited outlet directly to beach. Only the area of outlet onto beach is likely to be affected, upper reaches of creek likely to be above impacts. Creek has low structural complexity in estuarine vegetation communities, although does support some Saltmarsh EEC (GHD, 2007a). The estuarine reaches provide limited habitat for fauna (GHD, 2007a).			
Community Infrastructure							
Coalcliff Surf Club	Moderate		Moderate	Surf club is lower priority - this is just a shed (for storage) with a viewing platform (newly constructed storage building)	Council staff		B02031
Coalcliff SLSC Public Toilets Extension	Minor		Minor	Attached to SW end of SLSC			B03172
Coalcliff Boatshed	Minor		Minor	Building to south of SLSC			B02908
Leeder Park facility Toilet Block			Minor				B02242
Coalcliff Tidal Rock Pool (S end)	Major	Minor		Pool considered highly utilised / important to community, should be maintained. Council has indicated an engineering solution may be required.	Council staff		
Transport Infrastructure							
Beach access road and car park	Minor	Insignificant		Access to beach for cars will still be possible even with erosion impacts. Access to beach or properties during periodic inundation is not significantly affected.			
Water and sewage infrastructure							
Stormwater outlets and pipes			Major				
Residential Development							
Existing Residences (11 ppties N end, but edge of ppty below cliff)	Moderate	Moderate		Effect of this on redevelopment potential of properties	Community		
Existing Residences (19 N end but edge of ppty not houses, 26 centre of beach)			Moderate	Area has measured rates of movement (landslip), leading to strong controls on development. Development is allowed, so long is a suitable and correct design (in this area, can be expensive)	Council staff		
Vacant Land (Future Development) (4 N end)			Minor				

Clifton	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Moranga Park			Minor				
EEC Habitat Moranga Park Cliff Vegetation (local significance to heritage also)			Moderate				
Community Infrastructure							
Heritage Site: Coalcliff Colliery mine shaft (state significance)			Major	See comments in Appendix G from Hazards Study	Cardno, 2010		
Heritage Site: Imperial Hotel			Major				
Heritage Site: Stand of Norfolk Island Pines			Minor				
Heritage Site: Scarborough Hotel			Major				
Heritage Site: Police Station			Major				
Transport Infrastructure							
Seacliff Bridge and Lawrence Hargrave Drive			Major	Bridge has been built to withstand geotechnical hazards, therefore risk is mitigated. (Likelihood reduced to rare, consequence reduced to moderate (as impacts accounted for in design), risk level reduced to Low)			
Water and sewage infrastructure							
Stormwater outlets and pipes			Major				
Residential Development							
Existing Residences (22)			Moderate				
Institutional Infrastructure							
Primary School (heritage listed)			Major				

Scarborough & Wombarra	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Scarborough Wombarra Beaches	Major	Insignificant					
Scarborough Recreation Reserve, Jim Allen Oval Natural Area	Minor	Insignificant	Minor	Area presents a buffer for recession of the beach amenity, particularly as there are no significant dunes at the beaches (rocky pocket beach type).			
Jim Allen Oval	Minor	Minor		Park additionally has grounds for use in sports by community. Likely to be more limited facilities in northern end of LGA.			
Littoral Rainforest (N end of Scarborough Beach)	Moderate	Minor	Moderate				
Small creek / drainage line (S end of Scarborough beach)	Minor	Insignificant		Stormwater outlets feed into this creek (consequence for stormwater reviewed below). Likely to have limited habitat value as highly developed / existing stormwater impacts.			
Important Habitat (Scattered Blackbutt Forest EEC)			Moderate	Scattered trees interspersed with residential development, likely to have lower habitat value.			
Community Infrastructure							
Wombarra Rock Pool	Minor	Insignificant		Pool not considered as important to community, currently being managed to fail, is in poor repair and failing, no maintenance. However, pool requires tidal input and so may benefit from SLR	Council staff		
Wombarra Rock Pool Amenities	Minor	Insignificant					B03720
Heritage Site: Scarborough Cemetary			Minor	The heritage asset covers a large area, likely to be able to relocate affected burial sites.			
Seawall?	N/A	N/A	N/A	Apparently there is a failing seawall built in the Depression (1920s) located along Scarborough Beach. Unknown capacity of wall to protect from erosion impacts.	Workshop	Audit condition of existing structure. Refurbish as required.	
Scarborough/Wombarra SLSC			Major				B02032
Jim Allan Oval, Illawarra Park, Changerooms-toilets			Minor				B02243
Jim Allan Oval, Illawarra Park, Kiosk			Minor				B02244
Wombarra Community Hall and Child-Care Preschool			Moderate				B02143
Wombarra Community Hall and Preschool garage			Minor				B03745
Transport Infrastructure							
Lawrence Hargrave Drive			Major	Major Coastal Road linking to Seacliff Bridge			
Haig Street Reserve (Local Road and car park at Scarborough Beach)			Moderate	Boulders have been used to protect road area. Impacts to roadway would limit access to private properties in this location	Council staff		
Local road reserves and local roads			Minor				
Local roads (inc road access within William Sweeney park area at Wombarra)	Minor						
Railway System			Major	STA already undertaking action to reduce risk of landslip (both consequence and likelihood), risk level reduced to Low.			
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major	Major				
Residential Development							
Existing Residences (60)			Moderate				
Institutional Infrastructure							
Coledale Hospital			Major				

Coledale Beach extending to N edge of sharkys	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Coledale Beach	Major	Insignificant	Major				
Carricks Creek	Minor	Insignificant		Creek is essentially stormwater outlet located immediately south of SLSC. Likely to have limited habitat value, high disturbance.	Coledale Beach Reserve POM		
Stockyard Creek	Minor	Insignificant		Creek is essentially stormwater outlet located at northern end of the beach. EEC adjacent to creek further upstream.	Coledale Beach Reserve POM		
Dalys Creek	Minor	Insignificant		Creek is essentially stormwater outlet located at centre of the beach. Likely to have limited habitat value, high disturbance.	Coledale Beach Reserve POM		
EEC - Coastal Headland Banksia Scrub	Moderate	Minor	Moderate	EEC adjacent to Stockyard Creek.			
Community Infrastructure							
Coledale Surf Club	Minor	Moderate	Major	Coledale Beach Reserve POM stated that any new storage shed and / or SLSC needed to be behind the 50 yr line. At time of plan, club was operational and included a caretakers residence, but the facilities were inadequate, need for new storage shed (or new SLSC depending on funds) was flagged. Operate from a portable tower crane removal will cost around $5000 Concept designs in place for a relocatable structure (~$20,000-$30,000) that will have electricity and sewage connections, but can be moved by a crane at notice of a pending storm. With relocatable structure, risk level reduced to Insignificant (as the likelihood reduced to rare, and consequence reduced to minor based on cost of building).	Coledale Beach Reserve POM / Council staff	Relocatable structure design for new SLSC, reducing risk (likelihood) from coastal hazards	B02033
Coledale Beach Camping and Caravan Park	Minor	Minor	Minor	The campground also provides a buffer for recession of the beach.			
Coledale Beach Camping Reserve - Amenities Building	Minor		Minor	This is an aging asset, and redevelopment will be required in future, relocation or redesign is then possible	Council staff	Redesign / relocation of structure when replaced	B02011
Heritage Site: Norfolk Island Pines	Minor	Insignificant	Minor	*See comments for Thirroul*	Council staff		
Coledale seawall	N/A	N/A	N/A	There is a seawall located along the southern part of the beach (beginning adjacent but not in front of SLSC), extending ~ 200m. Coledale Beach Reserve POM (2004) stated the wall to be decaying and in need of repair. Unsure of protective ability, the wall may be just to provide beach access.	Coledale Beach Reserve POM	Audit of condition of seawall, repair/remove as recommended	
Coledale Rock Pool	Major	Minor		Money has been spent here to retain structure - seen as important to community - also recent cba showed its cheaper to fix than fill / decommission - the way its cut restricts water movement SLR woul probably help with this	Workshop		
Coledale Rock Pool toilets			Minor	West of Coledale Rock Pool			B02012
Transport Infrastructure							
Lawrence Hargrave Drive (Major Coastal Road)			Major				
Local Beach Access Road and car parking	Minor	Insignificant	Minor	Entire stretch of roadway backing the beach will be lost to erosion, however allows for recession of beach. Would require carpark further westward (immediately behind campground) and Lawrence Hargrave Drive to become main beach access route. (NB cadastral boundary for roadway extends beyond actual roadway). Periodic inundation likely to have limited damages or impacts.	Council staff		
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major	Major				
Residential Development							
Existing Residences (33 at S end of beach)			Moderate	Geotechnical issues unknown of in some of these areas	Community		
Institutional Infrastructure							
Coledale Public School - Grounds only	Minor		Minor	Erosion hazard only affects school grounds, not main building			
Coledale Public School - Buildings			Moderate				

Sharkys Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Sharkys Beach	Major	Insignificant	Major				
Public open space	Minor	Insignificant	Minor	This area immediately backing beach provides buffer to enable recession of the beach, particularly as there is little to no backing dunes.			
Community Infrastructure							
Heritage Site: Norfolk Island Pines (backing entire beach)	Minor	Insignificant	Minor	*See comments for Thirroul*	Council staff		
Shark Beach toilet block (mural painted)			Minor	South end of car park			B02013
Austinmer Boat Harbour toilets			Minor	Western side of car park that is adjacent to the harbour			B02412
Transport Infrastructure							
Lawrence Hargrave Drive (Major Coastal Road)			Major				
Car park (behind Sharkys beach and at boat harbour)	Minor	Minor	Minor	This area provides a buffer for recession of the beach amenity. Would need to be relocation to enable continued provision of parking for community associated with the Harbour.			
Sharkys / Austinmer Boat Harbour (Heritage listed)	Major	Major	Major	Concerns raised over availability of harbours for community use - there are very few harbours available in Wollongong.	Committee		
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major	Major				
Residential Development							
Vacant Land (Shark Park)	Minor	Insignificant	Minor	Shark Park - assume this is Council owned land, but is still currently zoned as residential land. (First residential cadastral block at N end of beach). The land could provide a buffer for recession of the beach amenity.		Rezoning to public open space	

Little Austinmer (Austinmer North) Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)	Council asset #
Parks, Beaches and open space								
Little Austinmer Beach	Major	Insignificant	Major					
Public open space	Minor							
Coastal Dune Systems	Major	Insignificant	Major					
Community Infrastructure								
Heritage Site: Norfolk Island Pines (backing entire beach)	Minor	Insignificant	Minor	*See comments for Thirroul*	Council staff			
Heritage Site: Glastonbury Gardens			Moderate	The gardens, as a heritage asset, are more spreadout, and therefore, the impacts can be managed across the site without loss of all heritage value.				
Tuckerman Park Toilet/Shed	Minor	Insignificant	Minor					B02249
Transport Infrastructure								
Lawrence Hargrave Drive (Major Coastal Road)	Catastrophic		Catastrophic	Major access route to Northern Wollongong LGA, limited land area for relocation.		Major access route to Northern Wollongong LGA, limited land area for relocation.		
Local roads and car park	Minor		Minor					
Water and sewage infrastructure								
Stormwater outlets and pipes	Major	Major	Major					
Residential Development								
Existing Residences (2)	Moderate			Community needs to have better information about development potential, development controls, and DA assessment requirements for coastal hazards, should they wish to subdivide (or sell)	Community*			
Existing Residences (14)			Moderate					
Commercial and Industrial Development								
Heritage site: Austinmer Headland Hotel			Major	While a private commercial asset, the site is heritage listed.				

Austinmer Beach	Erosion / Recession	Periodic Inundation	Periodic Inundation	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Austinmer Beach	Major	Insignificant	Major				
Austinmer Beach Reserve and Tuckermans Park	Minor	Minor					
Community Infrastructure							
Austinmer Surf Club	Major	Moderate	Major	Surfclub said to have been relocated in the 1980s.	??		B02034
Heritage Site: Norfolk Island Pines (backing entire beach)	Minor	Insignificant		*See comments for Thirroul*	Council staff		
Geologic Site: Rock headland / platform		Insignificant	Major	Little detail regarding this site.			
Austinmer Rock Pool	Major	Minor		Council has indicated Austinmer is a priority pool for community, and engineering solution may be required to retain pool. Walk from Thirroul to Austinmer Pool only possible at low tide, this will become impassable with sea level rise. Pool is easily accessible from Austinmer Beach, however.	Community* / Council staff		
Changeroom & toilets	Minor	Insignificant	Minor				B02014
Austinmer Boatshed	Insignificant	Minor	Insigificant	Immediately south of SLSC, site is associated with functioning of surf club. . Concept plans have been provided for an extension to the boatshed, to provide changerooms, gym, kitchenette and viewing facility. The plans have taken coastal hazards into consideration, therefore lower consequence from coastal erosion impacts is expected. Structure to be built on ground level at 4.8 m RL.	Council staff		B02015
Austinmer Seawall	N/A	N/A	N/A	There is said to be a substantial wall along this beach. Coastal engineering condition and protection from wall unknown. LPMA (Brian Dooley) has photographs.	LPMA / LIA Authority	Assessment of seawall condition. Repair and update hazard lines or remove as recommended.	
Transport Infrastructure							
Lawrence Hargrave Drive (Major Coastal Road)	Catastrophic	Major		Major access route to Northern Wollongong LGA, limited land area for relocation.			
Lawrence Hargrave Drive (Major Coastal Road) in area between Austinmer & Thirroul Beaches			Catastrophic	Major access route to Northern Wollongong LGA, limited land area for relocation. Given history of geotechnical hazards in this location, risk level reduced to low (likelihood rare, consequence minor as designed to accommodate landslip).			
Beach access and car park	Minor	Insignificant		Periodic Inundation would have limited impact to community services and limited damages.			
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major					
Stormwater outlets and pipes in area between Austinmer & Thirroul Beaches			Major				
Residential Development							
Existing Residences (~ 30) in area between Austinmer & Thirroul Beaches			Moderate				
Commercial and Industrial Development							
Neighbourhood Business Centre (local shops)		Moderate		Local shops said to have been raised and are on piles (done by developer), to accommodate inundation	Council		

Thirroul Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Thirroul Beach	Major	Insignificant		Said to be small amount of change in beach position in last 70 years. 1911 photograph of Thirroul Beach taken from southern end provided by local resident shows unvegetated dunes (higher than present), beach is similar position (refer copy of photograph).	Community*	Undertake dune establishment works to protect back beach development (inc residential ppties). May include sacrificing some assets to provide area for re-establishment (RA Workshop)	
Tingara Park	Minor	Insignificant		Except for small area (noted below) majority of beach has no coastal dune protection. Unsure of seawall structural condition for providing protection. Park area provides only available land for migration of beach amenity.			
Flanagans Creek	Minor	Insignificant		The creek is quite large, with vegetated foreshores. However the creek provides limited habitat for fauna and no EECs and limited estuarine vegetation types (GHD, 2007a). Therefore, impacts to habitat value from erosion considered minor, and from periodic inundation considered insignificant.	Council Staff		
Coastal Dune System (small area adjacent to creek outlet)	Major	Insignificant		Remainder of beach (ie, infront of seawall) has no dune system	Workshop		
Community Infrastructure							
Thirroul Surf Club	Major	Moderate		10 yr horizon for replacement of building	Council staff	Rebuild on same footrpint (e.g. double storey) to accommodate inundation, or relocate landward (RA Workshop)	B02035
Thirroul Pool (also heritage site)	Major	Minor		Pool shell will require replacement in next 5 - 10 yrs. Greater expectation from community for management from heritage perspective. Highly valued community asset.	Council staff	Allow pool to become a tidal pool, rebuild new pool landward (RA Workshop)	
Thirroul Pool office and amenities	Major	Moderate		Assume part of pool asset, therefore of higher consequence.			B02052
Thirroul Pool toilet	Major	Moderate		South end of pool. Assume part of pool asset, therefore of higher consequence.			B02053
Thirroul Pool storage shed (large)	Major	Moderate		South end of pool. Assume part of pool asset, therefore of higher consequence.			B03183
Thirroul Pool intake	Major	Moderate	Major	Blue building and pipes, southern end of beach. Provides for filling of pool, therefore part of pool asset and so higher consequence.			B02066
Heritage site: Thirroul Pavillion (being used as kiosk / restaurant) and residence	Major	Moderate		Council is currently processing a DA for refurbishment of the Pavillion (as both proponent and consent authority). Hazard assessment and design being completed by Cardno for this project. Seawall has possibly been incorporated into hazard assessment. Using State Govt guidelines for hazards consideration, in lieu of Wollongong specific hazard guidelines.	Council staff	Ensure refurbishment adequately considers design elements to accommodate coastal hazards	B02016
Heritage Site: Thirroul Beach Reserve (S of pool)	Moderate	Minor		Public open space that has heritage value, as part of Thirroul Beach precinct.			
Heritage Site: Norfolk Island Pines	Minor	Insignificant		Pines are a marker of the foreshore area. Currently strong restrictions on development near the pines, cannot be removed. Pines will have a limited lifespan and may perish over next 100 years. In future, the Pines are unlikely to be able to be relocated, but could be replanted (when undermined in future). The species is still commonly used in foreshore plantings. Protection may not be a viable option where pine will perish at some point in future.	Council staff		
Thirroul Beach seawall	N/A	N/A	N/A	Unsure of ability of seawall to protect against erosion. Was completely exposed after 1974 storms, apparently has piles to stronger foundation, however stormater erosion shows base of concrete at 1 -2 m AHD. Wall built in early 1950s (further information may be available from Brian Dooley at LPMA)	Council staff / LPMA	Rebuilding or enhancement along entire beach may be appropriate, as part of a local area planning strategy for Thirroul (RA Workshop)	
Heritage site: DH Lawrence House			Major	At southern "headland", house where DH Lawrence was staying when wrote "Kangaroo".	Council staff		
Heritage site: Former Quest House		Moderate					

Thirroul Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Transport Infrastructure							
Major Roads (Lawrence Hargrave Drive)		Major					
Local Roads (Bath St linking to the Esplanade, Henley St, Road reserve for Harbord & Ocean Sts)	Minor	Moderate					
Beach access and car park (N end of beach)	Minor	Minor					
Beach access and car park (S end of beach)	Minor	Minor					
Local Roads (*at headland south)			Minor				
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major		Cause erosion on beach during heavy catchment rainfall events		Scour protection for drainage outlets (RA Workshop)	
Thomas Gibson Creek - Stormwater outlet	Major	Major		This is the main stormwater line back through houses west of beach, exits to beach at southern end adjacent to pool intake. Flood management plan completed as part of Hewitts Creek FRMP. FRMP suggested opening the creek at 2.8 m RL, but this is essentially a stormwater outlet /drainage line rather than an entrance berm that would significantly impede flood flows?? As above, outlet causes erosion during heavy rainfall events. Residents affected by inundation (below) should already have Section 149 notation of flooding, as this creek (and its floodplain risk areas as per the FRMP) is contained in DCP E13. Creek is essentially a piped stormwater outlet, does not appear to have any associated habitat.	Hewitts Creek FRMP		
Stormwater outlets and pipes (*at headland south)			Major				
Residential Development							
Existing Residences (10 ppty at S end of beach toward DH Lawrence heritage site: 1 property at centre of beach)	Moderate		Moderate			Set foreshore building line, communicate risk and signal council intent (ie will not protect), develop local adaptation strategy, develop evacuation plan (RA Workshop)	
Existing Residences (extensive, relating to creek and stormwater pipe)		Moderate		Flanagans Creek & Stormwater drainage line - no flood study completed as yet, therefore the inundation levels provide first pass. Residents etc will not have been subject to flood controls (or Section 149) previously. Guidance and education required. Filling of 186 Lawrence Hargrave Drive residential property caused more flooding from upstream to ppty e.g. 182 / 184 L. H Drive. 1998 flood level reached laundry below house. Residents have raised concerns over changes to Section 149 - there needs to be better notation on what the risk actually is (ie, more than just "affected by coastal hazards", but explaining what hazard (e.g. inundation), what impact this may have (e.g. couple hours over high tide) and perhaps likelihood (e.g. possible / likely by 2100), to better convey to owners / potential buyers the risk. Understandably, the residents have raised questions about the science and modelling (e.g. neighbours there for 50 years have never seen inundation), as they are concerned about how the science affects their property value. However, they would be more comfortable to accept the science if better notation was on the Section 149 / available to community and buyers.	Community** / Community** * / Hewitts Creek FRMP	As above. For future development, DCP controls for inundation, potentially downgrade LEP zoning in high coastal inundation hazard zones, develop an evacuatio plan (RA Workshop)	
Existing Residences (21 from 157 Lawrence Hargrave Dr on headland north, 11 south to Cnr Craig St)			Moderate	At residence adjacent to pool intake = has a concrete seawall (headland), acting well to protect from cliff erosion There is an informal coal shaft within the two properties to the south of the seawalled ppty. Coal seam at base of cliff - unstable, sprayed concrete to fix*	Council staff / Community*	Set a Foreshore Building Line for geotech hazard (e.g. rock, platform and cliff along 'the Boulevarde), to manage land redevelopment (RA Workshop).	

McCauleys Beach (not inc Sandon Pt)	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
McCauleys Beach	Major	Insignificant		Beach is reported to have undergone extensive erosion over last 12 months, with active erosion escarpment migrating landward	LALC		
Woodland Avenue Reserve & Corbett Ave Reserve (public open space)	Minor	Insignificant		Known cliff erosion issues (highly erodable mudstones) at properties and "surfers car park" at end of street. Council plans to build wall to protect the end of street and provide improved beach access. Community has raised concerns over current steep, slippery beach access (made worse by dogs climbing up slope), and the beach access here is highly used.	Council staff / Community		
McCauleys Beach Reserve (park & open space)	Major	Moderate		Area listed as an Aboriginal Place (see below)	Council staff		
Hewitts Creek	Moderate	Minor		Hewitt Creek estuarine condition is classified as good (Cardno, 2010 CZS) Block at north eastern side, adjacent to creek = issues (high hazard area). Habitat and thick vegetation provide good refuge. Hewitts Creek FRMP recommends Council open lagoon / clear entrance when berm reaches RL 2.8 m. Needs to confirm with Council if this is done at present?? Creek and catchment may potentially be of higher value due to good condition of habitats. However, their good condition may assist to adapt (e.g. migrate) in response to coastal impacts	Community* / Community / Hewitts Ck FRMP		
Tramway Creek	Moderate	Minor		Tramway Creek estuarine condition is classified as good (Cardno, 2010 CZS) Hewitts Creek FRMP recommends Council open lagoon / clear entrance of Tramway when berm reaches RL 2.8 m. Needs to confirm with Council if this is done at present?? Creek and catchment may potentially be of higher value due to good condition of habitats. However, their good condition may assist to adapt (e.g. migrate) in response to coastal impacts.	Hewitts Ck FRMP		
Coastal Dune Systems (S end)	Major	Insignificant	Major				
Community Infrastructure							
Significant Aboriginal Site (Tent Embassy).	Major	Major		Heritage significance, also likely to be one of few Aboriginal areas. Council is purchasing land (~ $1.5 million) between and south of current tent embassy and cycleway. Other land to north is Council land, with provision for Tent Embassy as long as required. The Sandon Point Stockland development (West of Council / Aboriginal land) has been approved, some handing back of lands to Council for public use. Land between Tent Embassy and Stockland development is privately owned, but not developable. There are no plans to build any community or other structures on the Council land, land is to be maintained as open space (consistent with its heritage status). LALC recently completed a vegetation management plan for the area around the Tent Embassy with a CMA grant.	Council staff / LALC		
Cycleway / Shared Pathway (Northern Coastal Cycleway)	Moderate	Moderate	Moderate				
Transport Infrastructure							
Local Roads (inc Woodlands Ave, Corbett Ave)	Minor	Moderate		During inundation some houses could be cut off.			
Water and sewage infrastructure							
Stormwater outlets and pipes (N end of beach)	Major	Major					
Residential Development							
Existing Residences (1 ppty at N end of beach	Moderate	Moderate	Moderate	As below for flooding / inundation from Hewitts Ck			
Existing Residences (7 ppty at N end of beach, not inc ppty above)		Moderate		These properties are already located in the Medium Risk Flood Planning area, covered by Hewitts Creek FRMP, which sets development controls			
Existing Residences (10 ppty at N end of beach, south of DH Lawrence heritage site)			Moderate	Residents have raised concerns over crumbling cliff in this region. One resident raised question why hazard line isn't even larger, even greater hazard south of woodlands ave (Check with Peter Tobin). Want to protect properties against cliff erosion. No approval of coastal retaining walls, rejected DAs, but now eyesores constructed with no guidancne?? Want clear strategy for how to address crumbling clifffline, including protection of Woodlands and Corbetts Ave residences. Certainty for wall design and what would be acceptable.	Community**	
Vacant Land (Future Development?) (2 lots N end of Beach)	Minor	Insignificant	Minor	As above for flooding / inundation from Hewitts Ck			

Sandon Point Beach Boundary ends at car park on S	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Sandon Point Beach	Major	Insignificant					
Sandon Point Beach Reserve (not including Sandon Point Heritage area)	Minor	Insignificant		Reserve provides buffer area for roll back of beach and dunes.			
Slacky Creek	Minor	Minor		Slacky Ck comes under the Hewitts Ck FRMP, which recommends Council open lagoon / clear entrance when berm reaches RL 2.8 m. Needs to confirm with Council if this is done at present?? (also check EMPs). The lower estuarine reaches of Slacky Creek provide limited habitat for fauna, and structural complexity is low at the entrance bar, with only two estuarine vegetation communities and no EECs supported in the creek. (GHD, 2007a). Much further upstream there may be an EEC with good riparian habitat, may be affected by inundation, but not erosion.	Hewitts Ck FRMP		
Coastal Dune Systems (N end of beach)	Major	Insignificant					
Community Infrastructure							
Sandon Point Surf Club	Major	Moderate	Major	Re-development of SLSC in current location is planned. Not possible to relocate structure from current position to outside of hazard zone due to Aboriginal heritage of Sandon Pt. Significant money ($millions) planned for redevelopment. Site was subject to specific hazard study. Results have not been made available for CZMP (as yet), unknown what design or other provisions have been made to accommodate the immediate beach erosion hazard - it is expected the structure shall have foundation piles to rock and be designed to accommodate erosion, wave forces. Given location of SLSC near to Sandon Pt, likely to find stable rock for foundations, but will need to be built to withstand wave forces, erosion of sand, and occassional inundation in current location.	Council staff	Redevelopment of SLSC is currently underway - ensure redevelopment is built to withstand erosion, inundation hazards and wave impacts.	B02037
Heritate Site: Sandon Point (also under NPW Act)		Minor	Major	Heritage site includes for Aboriginal significance. Have received grant funding to do revegetation of Sandon Point. Nearshore reef is of high value to community (e.g. recognised surfing location, snorkelling, fishing). Weedy Sea Dragon habitat exists off Sandon Point	Council staff / Community / Community**		
Heritage Site: Sandon Point Boat Sheds		Minor	Moderate	Located along northern margin of Sandon Point itself (north around point from SLSC) Unusual lease arrangement (100yr with Lands) but if destroyed, current management approach is that they will not be rebuilt or protected. Currently in a state of disrepair, known to be subject to coastal processs in very vulnerable location. Still used occassionally.	Council staff	Retain current management approach	B03095
Northern Cycleway / Shared Pathway (at S end of beach)	Moderate			Where the cycleway eroded, a stormwater outlet was also replaced. No erosion design code for stormwater at present. Rocks used to prop up cycleway in this location.	Council staff		
Northern Cycleway / Shared Pathway		Minor	Moderate				
Heritage Site: Norfolk Island Pines (S end of beach)	Minor	Insignificant		*See comments for Thirroul*	Council staff		
Transport Infrastructure							
Local Roads: Blackall St, Ursula St, Alroy St)	Minor	Moderate					
Beach car parks (S end of Beach)	Minor	Minor					
Water and sewage infrastructure							
Stormwater outlets and pipes (S end of beach)	Major			Trinity Row inadequate drainage pipes at Ursula road and south between Ursula and Alroy Streets	Community*		
Residential Development							
Existing Residences (8 at S end of beach)	Moderate			Clarity required on effect of hazard on redevelopment potential of land.			
Existing Residences (adjacent to creek)		Moderate		As above, plus most of the affected ppties will already have Section 149 notation and be subject to Medium Risk Flood development controls (DCP E13). Only an extra 4 ppties affected by inundation compared with flood planning area (which was prob modelled without SLR)	Community / Hewitts Ck FRMP		

Bulli Beach (including Waniora Pt headland and	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Bulli Beach	Major	Insignificant	Major	Note the Bulli Area is listed on the Register of the National Estate*			
Bulli Beach Reserve	Minor	Insignificant	Minor	Reserve provides a buffer to enable roll back of beach			
Ocean Park	Minor	Insignificant		The area of land affected at Ocean Park is open space grassed area			
Whartons Creek	Minor	Insignificant		Creek supports only a few estuarine vegetation communities (no EECs), and structural complexity is low at the entrance bar. The estuarine reaches of Whartons Creek provide limited habitat for fauna (GHD, 2007a).			
Collins Creek	Moderate	Minor		The estuarine reaches of Collins Creek provide good potential foraging habitat for amphibians, microchiropteran bats, terrestrial and coastal birds, and birds of prey. Structural complexity is quite high at the entrance bar, with a mixed assemblage of saltmarsh species (an EEC), beach grasses and coastal dune vegetation. The coastal dune vegetation has been recently planted (GHD, 2007a)			
Coastal Dune Systems	Major	Insignificant		Dunes have be established at Bulli specifically to provide a buffer to erosion		Maintain dunes to provide erosion buffer (RA Workshop)	
Waniora Point (Heritage site)	Major	Moderate	Major	Area has high heritage significance. Grant recently received to protect Aboriginal midden, and rehabilitate from existing erosion impacts. Works will commence after summer, to reduce likelihood of public access / damage to works.	Council staff		
Community Infrastructure							
Bulli Surf Club	Major	Moderate	Major	DA on surfclub was refused. Norfolk Pine may limit moving the club; Dune vegetation and line of sight issues at this site - expressed an interest in helping with dune vegetation	Council / Community	Determine suitable relocation site, and relocate structure when trigger is reached (replacement schedule or distance from erosion scarp, whichever occurs first). (RA Workshop)	B02036
Bulli Kiosk and residence	Moderate	Moderate	Moderate	Plan to maintain current building (not rebuild as yet), with ~25 years life remaining on building. Recent maintenance works on building with grant including water tank ($50 - 100K).Kiosk also has a residence, recently signded 10 yr lease for tenants.	Council staff		B02017
Bulli Tourist Park (caravan park)	Moderate	Minor		Very high commercial value to Council, will be aiming to retain asset into the future. A new kiosk (temporary facility) has recently been built within the tourist park.	Council staff	Relocate cabins into adjacent park area when trigger is reached (replacement or distance from scarp), to maintain current commercial asset. (RA workshop)	Various*
Cycleway / Shared Pathway	Moderate	Minor	Moderate	At Waniora point, the cycleway was undermined during storms, prompting Council to rebuild and protect the path using rock to stop further erosion (unknown if was also raised for inundation).			
Bulli Pool	Moderate	Minor		Gets inundated with sand, requiring regular costly cleaning (~ $6K per clean). Woonona pool is located nearby, however site is said to also have community value.	Council staff	Engineering option to increase height of walls, with trigger of 0.2 m SLR for implementation (RA Workshop)	
Heritage Site: Bulli Cemetary		Minor		The heritage asset is covers a large area, likely to be able to relocate affected burial sites.			
Transport Infrastructure							
Car parks (Bulli SLSC, Collins Pt reserve)	Minor	Minor					
Local Road (Campbells St, Ocean St road reserve)		Moderate					
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major					
Residential Development							
Existing Residences (adjacent to creek)		Moderate		Residents have raised concerns over changes to Section 149 - there needs to be better notation on what the risk actually is (ie, more than just "affected by coastal hazards", but explaining what hazard (e.g. inundation), what impact this may have (e.g. couple hours over high tide) and perhaps likelihood (e.g. possible / likely by 2100), to better convey to owners / potential buyers the risk. Understandably, the residents have raised questions about the science and modelling (e.g. neighbours there for 50 years have never seen inundation), as they are concerned about how the science affects their property value. However,they would be more comfortable to accept the science if better notation was on the Section 149 / available to community and buyers. Also requested ground truthing / spot checks on ground along inundation boundary, to better confirm mapping.	Community**	Section 149 notification, redesign of structures (e.g. raising floor levels) (RA Workshop)	
Existing Residences (8 behind Waniora Pt)			Moderate	as above			
Institutional Infrastructure							
Bulli High School		Moderate					

Woonona Beach (extends to creek at centre of beach)	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Council asset #
Parks, Beaches and Open Space							
Woonona Beach	Major	Insignificant		At high tide, no beach, as dunes and incipient dunes with spinifex and *Acacia sophorae* in particular have grown and advanced significantly seawards (particularly compared with the wide beach area with no dunes during the 1970s). At high tide, the water extends to incipient dunes, no beach width for sunbathers.	Council Staff, community		
Nicholson Park, Beach reserve	Minor	Insignificant		Provides buffer for recession of beach amenity. Sports grounds on Nicholson Park would not be affected.			
Unnamed Creek and adjacent habitat	Moderate	Minor		Evidence of stormwater outlets flowing into the creek. Appears to be some habitat surrounding creek. Unsure of habitat value.			
Coastal Dune Systems	Major	Insignificant		Request for change in dunal species to allow viewing of the beach, removal of snakes/vermin and weeds. [NB - better education required to explain to community value of coastal dunes for erosion protection and habitat]. Concerns raised over dune species height (and dune height) that is now too high and too wide. One resident stated the dune height has blocked views from SLSC for members, and from roadway for surfers and passers by. This resident has lived in area whole life and remembers the beach in 1960s and 70s as having no dune, walk straight onto a wide low beach. On occassion, sand blown up over the road (either side of and into Nicholson Park). The sand was then mechanically shifted back onto the beach. After storms, the high tide came up to the present surf club. Resident said he preferred beach in those days, because could see water and have a wide beach for sun bathing, SLSC activities. Resident also said the dunes house rats, rabbits and weeds (prickly pear, bitou, asparagas weed), walkways are overgrown. Believes cant see beach from the lifeguard tower. Member from Woonona SLSC also noted the dune species were too high (blocking views at present) and incipient dunes presently too wide to provide much of a beach for sunbathers. Also noted dunes house rats, rabbits and weeds, and walkways are currently overgrown. Requested better species (and cropping of current dune species), but understands why the dunes are needed to protect from erosion. Member not opposed to being involved in volunteer dune care, changing species to lower grasses and shrubs, or use of portable platforms, as needed. But these concerns are also about beach amenity, not just lifeguarding.	Council staff, community (~ 4 different people)	Maintain dunes to provide erosion buffer (RA Workshop)	
Community Infrastructure							
Woonona Surf Club	Major	Moderate		Resident noted surf club has piers extending 18 m through the sand down to clay (there is no solid rock), when built.	Community		B02038
Lifeguard Tower	Minor	Insignificant					B03116
Woonona pool	Moderate	Insignificant		Pool may in fact improve with SLR, as currently pool only fills at top of tide, although pump station may be at risk. Pool is located on Collins Point at Northern end of beach. Pool has fairly high community value.		Engineering option to increase height of walls, with trigger of 0.4 m SLR for implementation (RA Workshop)	
Woonona Rock Pool Dressing Shed	Minor	Insignificant		Not actually beneath the erosion or inundation lines, but immediately adjacent to where they end. Possible that will be protected from erosion as founded on rock immediately behind the rock pool.			B02019
Cycleway / Shared Pathway	Minor	Minor				Relocate cycleway	
Transport Infrastructure							
Beach access and car parks	Minor	Minor	Minor				
Local Roads (Kurraba Rd, Park St, Beach Drive, Corinda Rd, Liamina Ave, Robertson Rd, Dorrigo Ave)	Minor	Moderate	Minor	Access to residential property is possible to be retained, even where local roads affected.		Alter traffic routes (inc bus), redesign road network to maintain access to residential properties, then allow road to be eroded (i.e. retreat) (RA Workshop)	
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major				Redesign network (over typical replacement schedule) to accommodate / mitigate inundation.	
Residential Development							
Existing Residences (19 at centre of bea	Moderate	Moderate		Concerned about effect of notation on property value and insurance	Community	For erosion: Section 149 notation, DCP controls for redesign, reducing development density, consider relocatable housing designs. For inundation: Section 149 notification, redesign of structures (e.g. raising floor levels) (RA Workshop)	
Existing Residences (5 at N end)			Moderate				
Existing Residences (adjacent to creek)		Moderate					

Bellambi Beach (not inc Bellambi Pt)	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Bellambi Beach	Major	Insignificant					
Beach Drive Park, Bellambi Natural Area, Bellambi Point Reserve, Bellambi Pool Reserve	Minor	Insignificant		Provides buffer for recession of beach amenity.			
Bellambi Gully and adjacent habitat	Moderate	Moderate		Bellambi Gully estuarine condition is classified as extensively modified (Cardno, 2010 CZS). However, the estuarine reaches of Bellambi Gully provide excellent potential foraging habitat for amphibians, microchiropteran bats, terrestrial, estuarine and coastal birds, and birds of prey (GHD, 2007a). Structural complexity is quite high at the entrance bar, with a mixed assemblage of saltmarsh species, beach grasses and coastal dune vegetation (GHD, 2007a), Bellambi Creek and Farrahers Creek run into Gully.			
Coastal Dune Systems	Major	Insignificant					
Community Infrastructure							
Bellambi SLSC		Moderate		Mural painted	Council		B02039
Cycleway / Shared Pathway	Moderate	Minor					
Bellambi Pool	Major	Minor		Pool has been maintained to better withstand wave impacts, $700000 recently spent on concorse and toddler pool upgrades. Recent works will have increased financial and community value.	Workshop		
Bellambi Pool Toilet Block		Insignificant					B02851
Bellambi Gully training wall	N/A	N/A		Not designed for hazards protection. Will probably need to be maintained to protect property.			
Bellambi boat ramp toilets (Old Coastguard building) - located at southen end of formal carpar area on Bellambi Point)		Insignificant	Minor		Council		B02596
Transport Infrastructure							
Bellambi pool car park	Minor	Insignificant					
Bellambi Boat Harbour	Major	Minor		Concerns raised over community usage of this - there are very few harbours available in Wollongong, functionality of ramp will be an issue	Committee		
Local Access road along coastline	Moderate	Moderate	Moderate	Access is constrained along this shoreline section, therefore local road needs to be retained, which could be done if area of parkland / open space / STP land used for local road.			
Water and sewage infrastructure							
Stormwater outlets and pipes	Major	Major					
Sewage Treatment Plant	Major	Major	Major				
Residential Development							
Existing Residences (~ 20 in 3 developments)			Moderate				

Bellambi Point Beach (to Lagoon entrance)	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Bellambi Point Beach	Major	Insignificant					
EEC area		Minor		EEC located within residential area, likely to be disturbed.			
Coastal Dune Systems	Major	Insignificant		Based on aerial photographs (see below) frontal dunes were vegetated very recently. Vegetation mapping describes the dunes as highly disturbed.			
Heritage Site: Bellambi Lagoon (Lake), Sandpit Point and associated habitat	Major	Moderate		Bellambi Lagoon is listed as being of local heritage significance, and also has high habitat value. There has been an ongoing problem relating to the breakout and northwards migration of the entrance channel, which is causing erosion of the northern dunes adjacent to entrance. There have been concerns raised by community over the erosion, which is destabilising attempts to revegetate the northern bank, and concerns the erosion will continue into the area of middens (which are located further back within the dunes beyond the immediate erosion area, but could potentially be impacted). (Discussion of aerials and DECC analysis of photogrammetry below ***). Solution being trialed is a hybrid approach entailing maintenance of a pilot channel and berm configuration to allow the entrance to breakout in the desired location (further south). Bellambi Lagoon is identified as a Highest priority site for restoration works. Bellambi Lagoon estuarine condition is classified as extensively modified (Cardno, 2010 CZS). However, GHD (2007a) found the estuarine reaches of Bellambi Lagoon provide excellent potential foraging habitat for amphibians, microchiropteran bats, terrestrial,	Council staff / workshop / DECC study into erosion / Illawarra Biodiversity Strategy 2010 (Draft)*	DECC study recommended options for management.	
Community Infrastructure							
Heritage Sites: Bellambi Point	Major	Moderate	Major	There are likely to be sites of Aboriginal heritage significance in this location. The area is now a nominated Aboriginal Place	Council staff / LALC	Need to develop strategy for managing hazard impacts to different types of heritage sites (e.g middens)	
Water and sewage infrastructure							
Sewage Treatment Plant	Major	Major	Major				

Corrimal Beach (extending from south of Bellambi	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Corrimal Beach	Major	Insignificant					
Corrimal Beach Natural Area: Coastal Dune Systems	Major	Insignificant		Has been illegal clearing recorded in the past. Vegetation mapping describes the dunes as highly disturbed with weeds, even though vegetation appears to be well established.	Council staff		
Towradgi Lagoon and adjacent EEC Habitat	Moderate	Moderate		One resident has concerns over "the effect of backup flooding due to the backup of water from Towradgi Creek. Have contacted the school re: block of stormwater drain at the rear of 4 Gregory Ave - no response forthcoming". Southern side of lagoon is identified as a High Priority site for restoration works. Trigger Level for opening: 1.6 m (with rain falling or impending), with alert level at 1.4 m (ie, to mobilise equipment for opening). If lagoon doesn't breakout and rainfall not impending, emergency trigger level set at 1.85 m, to alleviate flooding of property and assets beyond this level (e.g at 1.8 m some stormwater assets on Lake Pde and Parker Rd andflooding of ppty (not floors) on Parker Rd Arm, Parker Rd crossing at 1.94 m, overfloor flooding of ppties at 1.97 m). Towradgi Lagoon estuarine condition is classified as extensively modified (Cardno, 2010 CZS)	Community* / Illawarra Biodiversity Strategy 2010 (Draft)** / Towradgi Lagoon Entrance Management Policy		
Towradgi Park: Coastal Dune Systems (and small area of open space)	Minor	Insignificant					
Community Infrastructure							
Corrimal Surf Club		Minor		Has removable structure (sled system , no power or water supply)	Check this info??		B02040
Towradgi Rock Pool amenities mens	Minor	Insignificant		There are two blue roofed buildings at the far southern end of the beach (adjacent to roadway dividing this from Towradgi Beach). The mens amenities is slightly further north and in both hazard zones			B02020
Towradgi Rock Pool amenities womens	Minor			The womens building is slightly further south and not in inundation hazard zone.			B03148
Residential Development							
Existing Residences (adjacent to creek)		Moderate		The inundation extents (at 2100) lie wihtin the existing High or Medium Risk Flood planning area from the Towradgi Creek FRMP. Therefore, development controls and Section 149 notation shall already have been issued to residents. Noted by Committee that voluntary acquisition was offered to flood affected residents.	Towradgi Ck FRMP / Committee		

Towradgi Beach (extending to just north of Fairy	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Towradgi Beach	Major	Insignificant					
Towradgi Beach Park: Coastal Dune Systems	Major	Insignificant		Some areas of good vegetation, some areas of high disturbance (based upon vegetation mapping)			
Community Infrastructure							
Cycleway / Shared Pathway	Moderate	Minor					
Towradgi Pool	Major	Minor		Tidal, would require an engineering solution, highly utilised by the community (NB amenities buildings for the pool are located north, behind Corrimal Beach - see this beach for hazard details)			
Towradgi Beach Lifeguard Tower	Minor			Near (south east of) Towradgi SLSC.			B02049
Towradgi Protection Structure - Training wall?	N/A	N/A		At north end of Towradgi there is a Gabion mattress with toe 1m x 1m to protect the road and houses	LPMA		
Transport Infrastructure							
Local Roads: Towradgi Road, Marine Parade (N end of beach)	Moderate	Moderate		There may be difficulties maintaining access to some properties (as well as beach visitors) that will make these local roads more important and complicated to manage.			
Water and sewage infrastructure							
Stormwater outlet / pipe (N end)	Major						
Residential Development							
Existing Residences (4 at N end)	Moderate	Moderate		Clarity required on effect of hazard on redevelopment potential of properties	Committee		
Vacant Land - 15 lots N end currently vegetated with coastal dune vege'n (immediately adjacent to 2100 line)	Minor	Insignificant		These properties appear to be part of Towradgi beach Park and Coastal Dune Systems. Should not be zoned residential but maintained as environment protection / public recreation			

Fairy Meadow Beach (extends to immediately north of	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Fairy Meadow Beach	Major	Insignificant		Beach currently in eroded state, narrow beach face covered at high tide	Community		
Fairy Lagoon Habitat (part of Puckeys Estate lands)	Moderate	Moderate		Puckeys Estate (extending from northern edge of Lagoon northwards along Fairy Meadow Beach) is identified as a Highest priority site for restoration works. Puckeys Estate heritage assets included in North Beach assessment.	Illawarra Biodiversity Strategy 2010 (Draft)*		
Towradgi - Fairy Meadow Foreshore: Coastal Dune Systems	Major	Insignificant		Adjacent to Thomas Dalton Park. See above for proposed rehabilitation works.			
Community Infrastructure							
Fairy Meadow SLSC Lifeguard Tower	Minor	Insignificant		Small structure south east of SLSC			B03088

Wollongong North Beach	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
North Beach	Major	Insignificant					
Fairy Lagoon	Moderate	Moderate		Trigger Level for opening: 1.6 m (with rain falling or impending), with alert level at 1.3 m (ie, to mobilise equipment for opening). If lagoon doesn't breakout and rainfall not impending, can be broken out at 1.8 m, to alleviate flooding of Live Steamers Site beyond this level. Fairy Creek/Lagoon estuarine condition is classified as modified (Cardno, 2010 CZS)	Fairy Lagoon Entrance Management Policy	Allow retreat of lagoon (RA Workshop)	
Stuart Park (on heritage list, local significance)	Moderate	Minor		The site is heritage listed but provides open space that beach could recede into. At site of existing carpark - Strategy 6A Multi-deck public carpark with commercial / retail component with northern aspect overlooking Stuart Park	Blue Mile Foreshore Masterplan	Allow erosion/recession (ie retreat) (RA Workshop)	
Community Infrastructure							
Puckeys Estate including Seafield House and gardens ruins	Major	Major		At edge of Fairy Lagoon (NW of entrance), there are workings of a "salt" mine, used by Puckey. Periodic inundation could further degrade the limited house and garden remains	Council staff		
Lagoon Kiosk/Restaurant		Moderate		This is located at the end of the car parking immediately south of the lagoon (in the park).		Over the short term, build a bund to protect from coastal inundation to a certain trigger level. Abandon location after trigger/bund is reached, and relocate behind hazard area. (RA Workshop)	B02607
Stuart Park toilet block		Insignificant		South of Lagoon Kiosk/Restaurant			B02314
North Beach Surf Club	Major	Moderate	Major	Strategy 6B Construction of new SLSC to the north of existing building maintaining full access to beach with commerical component and public toilets, creating grassed terraced plaza with public seating and lighting [on old SLSC site]. Plans to knock down and rebuild this site (with State govt assistance) was flagged in the Wollongong City Foreshore POM. The former site will be grassed for public access and use (Strategy 6F). Designs for rebuilding SLSC have not yet been completed, but are intended to address coastal hazards. Unclear if relocation was considered (as proposed site is within hazard area), or if there were other constraints to relocation. Capability of existing seawall in front of site as protection from beach erosion is unknown, but suggested by Council to be inadequate. Pavillion seawall is intended to extend to [future] surf club in the future.	Blue Mile Foreshore Masterplan / Council staff	Ensure design is adequate to withstand future recession and inundation. Ensure extension of seawall to protect SLSC and adjacent buildings	B02043
Heritage Site: North Beach Kiosk	Major		Major	The structure is located next to the SLSC. The Kiosk structure is heritage listed and Council owned/ managed. It has high community value, as well as commercial value as functioning restuarant / kiosk. The Wollonong City Foreshore POM indicated this structure was renovated prior to operation of restaurant and kiosk	Foreshore POM	Extend new seawall at the Pavillion to protect this site also.	B02025

Wollongong North Beach	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Heritage Site: North Beach Pavillion	Major	Moderate	Major	Site is seen as a significant community asset with high heritage value. Community noted the pavillion to be a beautiful building of high value. Replacement of seawall across this property (see below) will protect this asset from coastal hazards, reducing the likelihood and impacts of coastal hazards. Strategy 6H Existing Bathers Pavillion building redeveloped incorporating restuarants, public toilets and improved access in accordance with NSW Heritage Office guidelines and DA approval process.	Council staff / Workshop / Community / Blue Mile Foreshore Masterplan	Seawall constructed to protect asset.	B02024
North Wollongong Beach Toliet Block			Minor	West of Pavilion (ie, immediately behind, likely to be protected by Pavillion wall).			B02023
North Beach Seawall				Seawall is to be replaced (cost ??~ $8 m). Existing crib lock wall is said to be on sand (not suitable toe for long term protection). New seawall will be emplaced in front and further east. As per Blue Mile, is will additionally provide beach access stairs and large seating stairs for public access. At present, the seawall will only protect the Pavillion. It is intended to be extended to the SLSC in the future. Has been designed to address coastal hazard issues (and the hazard lines assume this also, stopping at the wall).	Council staff / Blue Mile Foreshore Masterplan / Wollongong City Foreshore POM	Ensure design is adequate for future sea level rise recession and inundation	
Heritage Site: Norfolk Island Pines	Minor	Insignificant		There are ~ 150 Pines in North Beach to Brighton foreshores. *See comments on pines for Thirroul*	Council staff		
Cycleway / Shared Pathway	Major	Minor		Path between North Beach and Brighton Beach has heritage value as the former railway tramway, with former cutting remains. Path behind North Beach Pavillion to SLSC and Stuart Park - Strategy 6E Widening of existing shared use path with seating, shade, lighting etc. The improvements are intended to also include improved erosion protection for cycleway.	Council staff / Blue Mile Foreshore Masterplan	Ensure improvements include protection from coastal hazards	
Heritage listed: Battery Park Emplacements			Moderate	The emplacements are the concrete structures within Battery Park, and are heritage listed.			B02352
Water and sewage infrastructure							
Stormwater outlets / pipes (in Stuart Park)	Major	Major					
Transport Infrastructure							
Major roads (Pioneer Road)		Major		Some parts of this road are RTA road		Opportunistic raising of road (RA Workshop)	
Local road (beach access into Lagoon restaurant and car park)		Minor					

Brighton Lawn Reserve and Wollongong Harbour	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space				Coastal Management Plan for this area has recently been completed; copy provided to consultants.	Council staff		
Brighton Lawn Reserve Beach (Heritage listed)	Major	Insignificant		Wave focussing to S end of beach (through harbour mouth). Reported northerly sand drift, captured inside breakwalls at northern end of beach. Installation of seawall will result in loss of beach with sea level rise and recession, without mitigation.	Council staff		
Brighton Lawn Reserve: (Heritage Listed)	Minor			This land is protected by recently replaced Gabion rock wall (S end of beach) using plastic gabion baskets, to improve protection from erosion, therefore impacts from erosion will be mitigated. Was a former Lands/LPMA proposal for large scale development of the area, not approved.	Council staff		
Community Infrastructure							
Heritage Site: Flagstaff Hill and Lighthouse			Major	Strategy 3C involves construction of a Flagstaff Hill Visitors Centre (with kiosk, public toilets) within the park; and other strategies to improve / install walkways along perimeter for public use and access.	Blue Mile Foreshore Masterplan		
Heritage Site (state): Brighton Lawn Reserve / Harbour Precinct, including convict built steps and harbour breakwall	Major	Minor		The harbour is a very important asset from a heritage, community and economic (tourism, boating) view point. Need to consider how this can be maintained with sea level rise. Issues regarding how to preserve the assets with SLR without reducing their heritage value (e.g. building up the convict built breakwater or relocating it would reduce its value as a heritage item). There are lots of heritage items within the harbour, including convict built harbour breakwall which extends back into the edge of the lawn reserve (where lion statue is), the original convict harbour boat area and boat steps, and other younger features. the northern breakwall is relatively recent (~ 70s ?). The harbour, including heritage assets and working harbour, is seen as a significant community asset	Council staff / workshop		
Cycleway / Shared Pathway			Major	Path has heritage value as the former railway tramway, with former cutting remains between here and North Beach. Major upgrade to cycleway and pedestrial pathways between North and Brigton Beaches as below. The upgrades to cycleway are intended to also improve their protection from erosion. Unsure if SLR considered at this stage in upgrades. Strategy 5B Boardwalk projected over rock platform adjacent to lower tramway cutting (at base of Battery Park, on cliff section into North Beach). Strategy 5D Grade separate cyclists and pedestrians (ie, widen cycle and foot paths); Strategy 5G widen existing lower tramway shared way where appropriate, replace handrail, provide viewing platforms with shade seating and interpretive material.	Blue Mile Foreshore Masterplan		

Brighton Lawn Reserve and Wollongong Harbour	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Mens and Childrens Tidal Pools (Heritage listed)	Moderate	Insignificant		These are open ended pools, already being maintained to fail. (gentlemens baths are highly valued). Strategy 5H Maintain access to rock pool (formerly gentlemens baths) and pebbly beach. This suggests that will not be maintained to fail? Contradiction between advise from Council staff and BlueMile plan for pool management?	Council staff / Blue Mile Foreshore Masterplan	Continue current management, ie do nothing allowing pools to fail (RA Workshop)	
Continental Pool	Major	Minor	Major	Greater expectation from community for management from heritage perspective. Seen as a significant community asset. Strategy 5L potential upgrade of Continental Baths and building with potential commercial element. Unsure if this was to incorporate SLR or erosion provision.	Council staff / workshop / Blue Mile Foreshore Masterplan	Protect as a priority (RA Workshop)	
Continental Pool - Office/Amenities/Residence	Major	Moderate	Major				B02057
Continental Pool - Pumphouse/Garage	Major	Moderate	Major	South end of pools			B02067
Continental Pool - Storage Shed (North)	Major	Moderate	Major	North end of pools			B02068
Brighton Lawn Reserve Seawall	N/A	N/A		Strategy 4J - Major upgrade to seawall to additionally include improved beach access pathway network and seating, furniture and lighting for public. Gabion rock wall has been replaced (S end of beach) using plastic gabion baskets, to improve protection from erosion (as per CZMP for this area, see above). Design included access and seating arrangements as per the Blue Mile masterplan (photographs provided by Council)	Blue Mile Foreshore Masterplan		
Brighton Lawn Kiosk (heritage listed)	Major	Moderate	Major	Building in middle of reserve, behind harbour. The Kiosk building is heritage listed, part of the harbour precinct. A contractor operates a restaurant / kiosk from the buidling (see below)	Council Staff		B02301
Transport Infrastructure							
Local Roads (Cliff Rd, Endeavour Dr) and car parks			Minor				
Wollongong Harbour (heritage listed, state significant)	Major	Minor	Major	There is already pressure upon the heritage aspects, as the harbour is still commercially used. Strategy 4 A is to improve access to northern breakwater (built in 1970s) for public. Unsure if upgrade includes increasing height for SLR impacts	Council staff / Blue Mile Foreshore Masterplan	Raise harbour walls as necessary. For the inner harbour, do nothing. (RA Workshop)	
Water and sewage infrastructure							
Stormwater outlets / pipes			Major				
Commercial and Industrial Development							
Harbour Front Café Bar Restaurant		Moderate		This site is relatively recent (~ 10 yrs old). Strategy 4 X is for possible expansion of commercial opportunities to provide more dining, café and other recreation / leisure options.	Council staff		

City Beach (extending to end of showground/N	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
City Beach	Major	Insignificant		Before the dune revegetation works around 20 yrs ago, sand used to get blown across roadway into Brighton Beach, would be up to 3 -4 ft deep across roadway, roadway closed until this was removed. [NB - This would have allowed for sandbypassing into harbour and further north - erosion impacts on Brighton Beach will be partly caused by revege works on City Beach that have stopped windblown sand supply]	Community*		
Open space, parks etc	Minor	Insignificant					
Football Ground (WIN Stadium) and Showground	Major	Moderate		Concern raised over potential impact to this site. Grounds are likely to have high community significance, beyond their commercial value, representing the region's team.	Workshop		
Coastal Dune Systems	Major	Insignificant		Extensive revegetation work done after 1970s, has allowed build up of dunes to protect beach. However, now have concerns over aesthetics for SLSC members and users of cycleway because cant see beach over dunes. The Wollongong City Foreshore POM recommended additional view platforms be provided along this stretch, to facilitate better viewing by community (this does not appear to have been done). Dune restoration works are strategies (1F, 2L) in Blue Mile Masterplan (as well as other improvements to park plantings).	Community / Blue Mile Foreshore Masterplan		
Community Infrastructure							
City Beach Surf Club	Major	Moderate		Only designed for a 50 yr timeframe. Has 14 m deep pier foundations down to rock. Was built in 2004 with a 50 yr lease for developer (2 function centres, bar / restuarant and kiosk), in return for providing bottom level for SLSC use. SLSC doesn't have much view of beach, were apparently supposed to build at same height as the dunes, but have built behind and lower - only views from top levels. There are two lifeguarding towers (at either end of club, one for clubbies (S tower), one for council lifeguards, with suitable storage). The towers provide a good view of entire beach. Some trouble with accessing beach to set up equipment after storms, and for this reason lower dune species have been requested. (SLSC also requested shaving of dune to provide them with views from the club - but there are no issues for lifeguarding from their towers). They don't have any portable towers.	Council staff / Community*		B02907
Heritage Site: Former RC Cemetary, Graves and Monument	Moderate	Minor		Area has been redesigned to take advantage of historic significance. However, the historic sites are relocatable			
Site of former SLSC (now public viewing platform)	*Minor*			SLSC member notes erosion after 1964 storms - scarp was only 15 m seaward of the current road, then dropped 5 m to waterline. The scoreboard at the footballl stadium was washed away. The former SLSC had a pile wall built around it which was then back filled with basalt boulders, for protection. This untenable, and that is why ended up rebuilding. The scarp from the 1964 storm extended close to the current 2100 hazard (ZRFC) line. This demonstrates the value of the dune revegetation works, in now providing a buffer from erosion. Old photos of city beach from 1900 on are available on Councils libraries website. Current public viewing platform is on old SLSC site, is very likely that pile wall and basalt remains below the sand.	Community*		
Cycleway / Shared Pathway	Moderate	Minor					
Transport Infrastructure							
Local Roads (Marine Drive, Endeavour Drive, Quilkey Place) and beach access car parks	Minor	Minor		Access roads are not linked to residential property, thus periodic inundation less consequential			
Commercial and Industrial Development							
WIN Entertainment Centre	Moderate	Moderate		Concern raised over potential impact to this site	Workshop		
NB: Nuns Pools and Ladies Pool at rock platform off Flagstafff Hill		*Minor*		*Nuns pool does not have proper public access and Ladies pool has minor steep access. Neither of the pools are acting as viable pools at present. Heritage assets are already highly degraded, with reduced functionality.*	Council staff		

Coniston Beach	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Coniston Beach	Major	Insignificant					
Wollongong Golf Course	Minor	Y		Some community unconcerned about impact to golf course	Community		
Coastal Dune Systems	Minor	Insignificant					

Perkins Beach	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Parks, Beaches and open space							
Fishermans Beach (MM Beach?)	Major	Insignificant		There are likely to be midden sites at MM Beach	LALC		
Heritage listed: Hill 60 Nature Reserve	Minor	Minor	Moderate	Hill 60 area is heritage listed, however is mostly public open space.			
Port Kembla - Perkins Beach	Major	Insignificant		There are known to be Aboriginal burial sites at Windang	Council / LALC		
Coastal Dune Systems: Pork Kembla Beach, Perkins Beach Reserve	Major	Insignificant		Entire length of beach and coastal dune system is identified as a Highest priority site for restoration works. 4WD and trail bike access through dunes and along beach is destabilising dunes. Believe Council is not as involved in revegetation, updating dune fencing, weed control on dunes any more. More maintenance required. Many areas classified as high disturbance (based on vegetation mapping).	Illawarra Biodiversity Strategy 2010 (Draft)*		
Community Infrastructure							
Hill 60 Battery viewing platform			Minor				B02407
Hill 60 Lookout/Battery			Minor				B02411
Coastguard Complex Port Kembla			Minor				B03080
Port Kembla Olympic Pool	Major	Minor		More community expectation to maintain this pool (from heritage and community perspective). Pool has been maintained to better withstand wave impacts	Council staff / Workshop		
Port Kembla Pool - Amenities/Kiosk/Lifeguard Tower	Major	Moderate	Major	North-west of pool			B03182
Port Kembla Pool - Pumphouse		Moderate	Major	South end of pool			B02059
Port Kembla Pool - Residence & pool office		Moderate	Major	North end of pool			B02058
Port Kembla SLSC - Lower boat shed			Major	North of pool complex			B02026
Windang Surf Club		Moderate		Concern raised over community impact from damage to this structure	Workshop		B02046
Windang Beach Dressing rooms / toilets		Insignificant		Immediately behind SLSC.			B02027
Transport Infrastructure							
Lake Illawarra Training Walls	Major	Minor		Concern raised over community impact from damage to this structure, expensive structure	Workshop		
Water and sewage infrastructure							
Port Kembla Sewage Treatment Plant			Major				

Lake Illawarra Foreshores	Inundation	Comments / Reason for consequence level (if diff't from main grouping)	Comments from	Potential Management Options?	Council asset #
Parks, Foreshores and open space	**Consequence**				
Lake Illawarra Foreshore	Minor	Foreshore land is largely open space that could enable recession / inundation			
Windang Foreshore Park	Minor	as above			
Boronia Park / Oval	Minor	as above			
Kully Bay Park	Minor	as above			
Hooka Point Park	Minor	as above			
Fred Finch Park Natural Area	Minor	as above			
Purrah Bay Reserve	Minor	as above			
Koonawarra Bay reserve / park	Minor	as above			
Lakeside Drive Reserve	Minor	as above			
Holbom Park Sailing Club	Minor				
Windang Bowls Club (private recreation)	Minor				
Illawarra Yacht Club (private recreation)	Minor				
EEC Swamp Oak Floodplain Forest	Moderate				
EEC Coastal Swamp Oak Forest	Moderate				
Community Infrastructure					
Windang Tourist Park	Moderate	Concern raised over community impact from inundation of this location. Social equity - caravan park residents and other residents along Windang Peninsula foreshores - cant afford to help themselves. Community concerns indicate such parks in this area are more like residential development.	Workshop / Community		
Other caravan parks	Moderate				
Lake Illawarra Cycleway / Shared Pathway	Minor	Cycleway around foreshore is too low. New cycleways need to take into consideration sea level rise and setbacks	Community		
Windang Memorial Park - Toilets	Minor				B02368
Windang Memorial Park - Tennis Clubhouse (leased)	Minor				B02502
Boronia Park Dressing Sheds / toilets / gardeners	Minor				B02370
Boronia Park Kiosk	Minor				B02371
Boronia Park Pigeon Clubroom	Minor				B02369
Boronia Park Scout Hall	Minor				B02441
Fred Finch Park Baseball Kiosk	Minor				B02376
Fred Finch Park amenities	Minor				B03161
Fred Finch Park Pony Clubhouse	Minor				B02404
Fred Finch Park - Berkeley Basketball Stadium	Moderate				B02831
Willam Beach Park Exeloo, Brownsville	Minor				B02391
Transport Infrastructure					
Major roads, bridges: Windang Rd and Bridge	Major				
Local Roads, car parks	Minor				
Port Kembla Sailing Club Boat ramp and harbour	Moderate				
Water and sewage infrastructure					
Stormwater outlets / pipes	Major				
Residential Development					
Existing Residences (numerous)	Moderate	Resident concerrned about future redevelopment, subdivision, on existing properties along Mullet Ck. His example is the Lakeline retirement village, which was developed by placing fill on the floodplain to raise the height of the development. He does not want this type of development to occur on the other remaining blocks. Beleives that the Lakeline village development has increased the flooding problem for his property			
Vacant Land (Future Development: Tourist zone at Kully Bay)	Insignificant				
Vacant Land (3 residential zoned blocks at Purrah Bay)	Insignificant				
Note: 674 land parcels affected					
Commercial and Industrial Development					
Oasis Resort and Caravan Park	Moderate	See notes on Windang Caravan Park. This site is also a private commercial enterprise.			
Tru Energy Gas Powered Station	Major				
Institutional Infrastructure					
Windang Public School	Moderate				
Primbee Heights		Geotech hazard (Barry, 118 Lakeview Parade Primbee) - resident wants to understand what this means			

APPENDIX F: THIRROUL CASE STUDY ECONOMIC ANALYSIS OF MANAGEMENT OPTIONS: GILLESPIE ECONOMICS

Benefit Cost Analysis

of

Sea Level Rise Management Options

Thirroul Beach Case Study

Draft Report

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1.0 INTRODUCTION

Predicted sea level rise as a result of climate change can have a number of consequences for the coastal environment, including for infrastructure assets and recreational use. Investments to reduce the impacts of sea level rise also have a range of costs and benefits to the community. Consideration of the magnitude and distribution of these costs and benefits is necessary to ensure that decision-makers are fully informed of the consequences of different policy options.

This report uses a benefit cost analysis (BCA) framework to undertake a case study analysis of different investment options to reduce the impacts of sea level rise on Thirroul beach and its environs. To undertake this quantitative analysis it was necessary to make a range of assumptions around which there is considerable uncertainty. While some sensitivity testing of these assumptions has been undertaken, the analysis can be updated if better information becomes available.

2.0 BENEFIT COST ANALYSIS

2.1 Introduction

BCA involves the following key steps:

- identification of the base case or "without" investment case;
- identification of the "with" investment options;
- identification of the incremental costs and benefits of investment options;
- physical quantification and valuation of the investment options' incremental benefits and costs;
- consolidation of values using discounting to account for the different timing of costs and benefits;
- application of decision criteria;
- sensitivity testing; and
- consideration of non-quantified benefits and costs, where applicable.

2.2 IDENTIFICATION OF THE BASE CASE

In the absence of any form of investment, sea level rise is predicted to result in both inundation and erosion effects at Thirroul.

An increase in the occurrence of inundation will result in periodic damage to up to 71 properties[1], with the probability of an occurrence assumed to increase from 1:100 in 2011 to 1:10 in 2050 and 1: 1 in 2100. Damage costs are assumed at $70,000 per property per incident.

Erosion is assumed to result in the loss of a number of beach side assets in 2011, including Thirroul Surf Club, Thirroul Pool, Thirroul Pavillion and Thirroul beach reserve. These facilities have a range of economic use values. Heritage sites such as the Thirroul Pool, Thirroul Pavillion and Thirroul Beach Reserve also have non-use heritage values. These values will be lost under the base case.

The economic value of nine private residences will be lost in 2050 if no investment occurs to reduce the consequences of sea level rise.

Under the base case, the coastal dune system is assumed to migrate naturally landward and hence there is no loss of use values associated with Thirroul Beach.

This dune migration does however result in some loss of stormwater assets.

[1] An additional 80 properties would also be subject to periodic damage from an increase in the occurrence of inundation, however, these are already subject to planning controls.

2.3 IDENTIFICATION OF INVESTMENT OPTIONS

Three investment options to reduce the impacts of sea level rise are analysed in this BCA:

- Option 1 - sea wall - with beach nourishment;
- Option 2 - sea wall - without beach nourishment;
- Option 3 - planned retreat.

2.4 IDENTIFICATION OF THE INCREMENTAL COSTS AND BENEFITS

The categories of costs and benefits of these options relative to the base case are summarised in Table 1.

COST AND BENEFIT CATEGORIES	OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT	OPTION 2 - SEA WALL - NO NOURISHMENT	OPTION 3 - PLANNED RETREAT
Costs			
Cost of relocating Thirroul surf club			*
Cost of relocating Thirroul pool			*
Cost of relocating Thirroul pavillon			*
Cost of planning controls on 9 properties plus 151 properties			*
Capital costs of seawall	*	*	
Maintenance costs of seawall	*	*	
Beach nourishment costs	*		
Costs of maintaining pool, pavillion, surf club plus beach			*
Costs of maintaining pool, pavillion, surf club, reserve plus beach	*		
Costs of maintaining pool, pavillion, surf club and reserve		*	
Loss of beach use values		*	
Benefits			
Avoided Inundation damage			*
Avoided Erosion Damage			
Avoid loss of Thirroul Surf Club	*	*	*
Avoid loss of Thirroul pool - use	*	*	*
Avoide loss of Thirroul pool lost - heritage site	*	*	*
Avoid loss of Thirroul pavillion use values -restaurant and residence	*	*	*
Avoid loss of Thirroul pavillion - heritage site	*	*	*
Avoid loss of Thirroul beach reserve - use	*	*	
Avoid loss of Thirroul Beach reserve - heritage site	*	*	
Avoid stormwater asset lost - end of pipe	*	*	
Avoid/delay loss of private properties (2050)	*	*	*

2.5 VALUATION OF COSTS AND BENEFITS

Valuation of costs and benefits required a number of assumptions about the annual use for different coastal assets as well as assumptions about the use and non-use economic values. Assumptions area specified in the attached spreadsheets.

2.6 CONSOLIDATION OF VALUE ESTIMATES

The present value of costs and benefits for each option are presented in Table 2.

Table 2 - Benefit Cost Analysis Results (7% discount rate)

	OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT	OPTION 2 - SEA WALL - NO NOURISHMENT	OPTION 3 - PLANNED RETREAT
COST			
Cost of relocating Thirroul surf club			$233,645
Cost of relocating Thirroul pool			$560,748
Cost of relocating Thirroul pavillon			$233,645
Cost of planning controls on 9 properties			$1,104,060
Capital costs of seawall	$3,831,776	$3,831,776	
Maintenance costs of seawall	$2,730,343	$2,730,343	
Beach nourishment costs	$12,091,865		
Costs of maintaining pool, pavillion, surf club plus beach			$1,477,581
Costs of maintaining pool, pavillion, surf club, reserve plus beach	$1,603,010		
Costs of maintaining pool, pavillion, surf club and reserve		$1,555,974	
Loss of beach use values		$142,533,279	
TOTAL COSTS	**$20,256,994**	**$150,651,372**	**$3,609,678**
BENEFITS			
Avoided Inundation damage	$0	$0	$1,612,819
Avoided Erosion Damage			
Avoid loss of Thirroul Surf Club	$712,666	$712,666	$712,666
Avoid loss of Thirroul pool - use	$71,266,640	$71,266,640	$71,266,640
Avoid loss of Thirroul pool lost - heritage site	$475,523	$475,523	$475,523
Avoid loss of Thirroul pavillion use values -restaurant and residence	$8,979,597	$8,979,597	$8,979,597
Avoid loss of Thirroul pavillion - heritage site	$475,523	$475,523	$475,523
Avoid loss of Thirroul beach reserve - use	$28,506,656	$28,506,656	
Avoid loss of Thirroul Beach reserve - heritage site	$475,523	$475,523	
Stormwater asset lost - end of pipe	$0	$0	
Avoid/delay loss of private properties (2050)	$5,500,001	$5,500,001	$5,162,471
TOTAL BENEFITS	**$116,392,128**	**$116,392,128**	**$88,685,238**
NET BENEFITS	**$96,135,134**	**-$34,259,244**	**$85,075,561**
BCR*	**6.2**	**-4.2**	**83.8**
NPV/I**	$5.2	-$5.2	$82.8

*Cost in BCR is capital and operating cost of the action e.g. seawall capital and operating costs and beach nourishment for option 1.
**I is defined to include capital, maintenance and beach nourishment costs.

There are two main decision criteria for assessing the economic desirability of an investment to society:

- net present value (NPV) which is the present value of benefits less the present value of costs. Under this decision rule, an investment is potentially worthwhile (or viable) if the NPV is greater than zero. Both Option 1 and Option 3 are therefore economically viable.

- benefit cost ratio (BCR) which is the present value of benefits divided by the present value of costs. An investment is potentially worthwhile if the BCR is greater than 1. Under this criterion both Options 1 and Option 3 are economically viable.

Where investments are mutually exclusive and there is no capital constraint, the investment which yields the highest NPV would be chosen as the most economically efficient – Option 1. However, this option also requires considerable capital and ongoing costs – 16 times that of Option 3. Where there are constraints on capital funds the problem facing decision-makers is to rank investments in terms of return to the constrained input. The BCR does this to a certain extent (depending on which costs are included in the denominator) however more explicitly NPV per dollar of total capital invested (NPV/I) can be used to maximises the total NPV obtained from a limited capital works budget. In this case, however, funds for both the capital and direct ongoing costs of options are constrained. NPV per dollar invested (both capital and operating costs) has therefore been estimated. On this basis, Option 3 is the preferred option.

2.7 SENSITIVITY ANALYSIS

This NPVs presented in Table 2.2 are based on a range of assumptions around which there is some level of uncertainty. Uncertainty in a BCA can be dealt with through changing the values of critical variables in the analysis to determine the effect on the NPV or NPV/I. From Table 2 it is evident that the key drivers in the analysis relate to loss of beach use values, avoided loss of Thirroul pool use values and avoided loss of Thirroul beach reserve use.

For Option 2 the main cost that drives the analysis is the loss of beach use values. A 24% reduction in loss of beach use values is required to make Option 2 have a positive NPV and a 84% reduction is required for Option 2 to have a higher NPV than Option 3. However, even if there is no loss in beach use under this Option 2 the NVP/I is less than for Option 3.

Avoided loss of Thirroul pool use values is a major and common benefit to Option 1, 2 and 3. Changes in this assumption therefore do not change the relative ranking of the investment options. Even if these benefits are assumed to be zero both Options 1 and 2 have a positive NPV with Option 3 having the highest NPV/I.

Avoided loss of use values from Thirroul beach reserve is another major benefit of Options 1 and 2. A 520% increase in the avoided loss of use benefits from Thirroul beach reserve would be required for Option 1 to have an NPV/I greater than Option 3.

2.8 DISTRIBUTIONAL AND FINANCING CONSIDERATIONS

The main benefit of the preferred investment, Option 3, accrues to those people who use the Thirroul pool and to a lesser extent the tenants of the Thirroul Pavillion and private property owners. Private property owners bear all the costs (i.e. the cost of planning controls) that result in their individual benefit (delay in property erosion). The remainder of the costs are borne by Council in the first instance. There is therefore some rationale under this option for Council to recoup costs from users of the relocated pool and tenants of the Thirroul Pavillion. Whether this is feasible will depend to some extent on size of the charge and the price elasticity of demand of users. For instance, if recouping the costs results in a larger user fee for the Thirroul pool than other pools in the region and users have elastic demand curves they may simply use other pools in the region rather than paying a higher fee. Since the pool is provided for the use of all households in the region an alternative would be an additional levy on all households.

3.0 CONCLUSION

Option 3 – Planned Retreat would result in the greatest net benefit per dollar (capital and maintenance costs) invested. Given that Thirroul beach is only one of many that may be impacted by

sea level rise, options that provide greater net benefits e.g. Option 1, but come at a greater capital and maintenance cost burden could be considered to be inferior to those providing a greater NPV/I. With a planned retreat option there is some rationale for the recoupment of costs from users of the relocated Thirroul Pool and tenants of Thirroul Pavillion. An alternative would be a levy on all households in the Wollongong LGA.

				1	2	3	4	5	6	7	8	9	10
	4%	7%	10%	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BASE CASE	No loss of beach under base case as natural migration of dune occurs												
Inundation													
Probability				0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Houses impacted				71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	$13,623,861	$3,982,725	$1,822,269	49,700	61,169	72,638	84,108	95,577	107,046	118,515	129,985	141,454	152,923
Erosion													
Thirroul Surf Club lost	$1,213,364	$712,666	$499,906	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	$121,336,388	$71,266,640	$49,990,589	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	$809,610	$475,523	$333,560	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	$15,288,385	$8,979,597	$6,298,814	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	$809,610	$475,523	$333,560	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	$48,534,555	$28,506,656	$19,996,236	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Thirroul Beach reserve - heritage site	$809,610	$475,523	$333,560	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe	$0	$0	$0										
Private properties lost (2050)	$27,389,785	$5,500,001	$1,315,778	0	0	0	0	0	0	0	0	0	0
Total costs	$229,815,169	$120,374,853	$80,924,270	7,829,787	7,841,256	7,852,725	7,864,194	7,875,664	7,887,133	7,898,602	7,910,071	7,921,541	7,933,010
Benefits													
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach	$2,729,235	$1,603,010	$1,124,445	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT	no loss of beach under this option												
Costs													
Capital costs	$3,942,308	$3,831,776	$3,727,273	$4,100,000									
Maintenance costs	$4,777,677	$2,730,343	$1,863,251	0	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Beach nourishment costs	$19,642,766	$12,091,865	$8,862,225	2250000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	$2,729,235	$1,603,010	$1,124,445	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	$31,091,985	$20,256,994	$15,577,193	$6,462,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466
Benefits													
Avoided Inundation damage	$0	$0	$0	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage													
Avoid loss of Thirroul Surf Club	$1,213,364	$712,666	$499,906	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	$121,336,388	$71,266,640	$49,990,589	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values -resta	$15,288,385	$8,979,597	$6,298,814	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	$48,534,555	$28,506,656	$19,996,236	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	$0	$0	$0	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	$27,389,785	$5,500,001	$1,315,778	-	-	-	-	-	-	-	-	-	-
Total Benefits	*$216,191,308*	*$116,392,128*	*$79,102,002*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*
Net Benefits	$185,099,323	$96,135,134	$63,524,809	1,317,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621
BCR		6.2											
NPV/I		25.1											
NPV/I k + op costs		5.2											

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
BASE CASE																				
Inundation																				
Probability	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	164,392	175,862	187,331	198,800	210,269	221,738	233,208	244,677	256,146	267,615	279,085	290,554	302,023	313,492	324,962	336,431	347,900	359,369	370,838	382,308
Erosion																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe																				
Private properties lost (2050)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total costs	7,944,479	7,955,948	7,967,417	7,978,887	7,990,356	8,001,825	8,013,294	8,024,764	8,036,233	8,047,702	8,059,171	8,070,641	8,082,110	8,093,579	8,105,048	8,116,517	8,127,987	8,139,456	8,150,925	8,162,394
Benefits																				
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values -resta	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Benefits	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*
Net Benefits	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621
BCR																				
NPV/I																				
NPV/I k + op costs																				

	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
BASE CASE																				
Inundation																				
Probability	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.1	0.12	0.14	0.15	0.17	0.19	0.21	0.23	0.24	0.26	0.28
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	393,777	405,246	416,715	428,185	439,654	451,123	462,592	474,062	485,531	497,000	586,460	675,920	765,380	854,840	944,300	1,033,760	1,123,220	1,212,680	1,302,140	1,391,600
Erosion																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe																				
Private properties lost (2050)	0	0	0	0	0	0	0	0	0	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000
Total costs	8,173,864	8,185,333	8,196,802	8,208,271	8,219,741	8,231,210	8,242,679	8,254,148	8,265,617	13,677,087	13,766,547	13,856,007	13,945,467	14,034,927	14,124,387	14,213,847	14,303,307	14,392,767	14,482,227	14,571,687
Benefits																				
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pavillion use values -resta	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*7,780,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*
Net Benefits	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621
BCR																				
NPV/I																				
NPV/I k + op costs																				

	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080
BASE CASE																				
Inundation																				
Probability	0.30	0.32	0.33	0.35	0.37	0.39	0.41	0.42	0.44	0.46	0.48	0.50	0.51	0.53	0.55	0.57	0.59	0.60	0.62	0.64
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	1,481,060	1,570,520	1,659,980	1,749,440	1,838,900	1,928,360	2,017,820	2,107,280	2,196,740	2,286,200	2,375,660	2,465,120	2,554,580	2,644,040	2,733,500	2,822,960	2,912,420	3,001,880	3,091,340	3,180,800
Erosion																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe																				
Private properties lost (2050)	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000
Total costs	14,661,147	14,750,607	14,840,067	14,929,527	15,018,987	15,108,447	15,197,907	15,287,367	15,376,827	15,466,287	15,555,747	15,645,207	15,734,667	15,824,127	15,913,587	16,003,047	16,092,507	16,181,967	16,271,427	16,360,887
Benefits																				
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pavillion use values -resta	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*
Net Benefits	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621
BCR																				
NPV/I																				
NPV/I k + op costs																				

	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
BASE CASE																				
Inundation																				0
Probability	0.66	0.68	0.69	0.71	0.73	0.75	0.77	0.78	0.80	0.82	0.84	0.86	0.87	0.89	0.91	0.93	0.95	0.96	0.98	1.00
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	3,270,260	3,359,720	3,449,180	3,538,640	3,628,100	3,717,560	3,807,020	3,896,480	3,985,940	4,075,400	4,164,860	4,254,320	4,343,780	4,433,240	4,522,700	4,612,160	4,701,620	4,791,080	4,880,540	4,970,000
Erosion																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe																				
Private properties lost (2050)	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$5,400,000	$77,142,857
Total costs	16,450,347	16,539,807	16,629,267	16,718,727	16,808,187	16,897,647	16,987,107	17,076,567	17,166,027	17,255,487	17,344,947	17,434,407	17,523,867	17,613,327	17,702,787	17,792,247	17,881,707	17,971,167	18,060,627	89,892,944
Benefits																				
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466	$1,067,466
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pavillion use values -resta	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	77,142,857
Total Benefits	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*13,180,087*	*84,922,944*
Net Benefits	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	83,855,478
BCR																				
NPV/I																				
NPV/I k + op costs																				

	4%	7%	10%	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
OPTION 2 - SEA WALL - NO NOURISHMENT	Loss of beach under this option												
Costs													
Capital costs	$3,942,308	$3,831,776	$3,727,273	$4,100,000									
Maintenance costs	$4,777,677	$2,730,343	$1,863,251	0	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Costs of maintaining pool pavillion, surf club and reserve	$2,649,153	$1,555,974	$1,091,451	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	$242,672,776	$142,533,279	$99,981,178	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	$254,041,913	$150,651,372	$106,663,153	*$14,209,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*
Benefits													
Avoided Inundation damage	$0	$0	$0	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage	$0	$0	$0										
Avoid loss of Thirroul Surf Club	$1,213,364	$712,666	$499,906	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	$121,336,388	$71,266,640	$49,990,589	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	$15,288,385	$8,979,597	$6,298,814	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	$48,534,555	$28,506,656	$19,996,236	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	$0	$0	$0	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	$27,389,785	$5,500,001	$1,315,778	-	-	-	-	-	-	-	-	-	-
Total Benefits	$216,191,308	$116,392,128	$79,102,002	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087
Net Benefits	-$37,850,605	-$34,259,244	-$27,561,151	- 6,429,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	2,534,079
BCR		-4.2											
NPV/I		-8.9											
NPV/I k + op costs		-5.2			50								
OPTION 3 - PLANNED RETREAT	No loss of beach under this options			No opportunity cost of land used for relocation as spare open space									
Cost of relocating Thirroul surf club	$240,385	$233,645	$227,273	250,000									
Cost of relocating thirroul pool	$576,923	$560,748	$545,455	600,000									
Cost of relocating Thirroul pavillon	$240,385	$233,645	$227,273	250,000									
Cost of planning controls on 9 properties plus 71 properties	$1,718,575	$1,104,060	$793,185	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000
Costs of maintaining pool pavillion, surf club and beach	$2,515,683	$1,477,581	$1,036,461	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	*$5,291,950*	*$3,609,678*	*$2,829,647*	*1,283,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*
				71	*70*	*68*	*67*	*65*	*64*	*62*	*61*	*60*	*58*
Benefits													
Avoided Inundation damage	$2,660,675	$1,612,819	$1,082,145	49,700	59,946	69,733	79,061	87,931	96,342	104,294	111,787	118,821	125,397
Avoid loss of Thirroul Surf Club	$1,213,364	$712,666	$499,906	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	$121,336,388	$71,266,640	$49,990,589	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	$15,288,385	$8,979,597	$6,298,814	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	$809,610	$475,523	$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	$23,026,109	$5,162,471	$1,287,755	0	0	0	0	0	0	0	0	0	0
Total Benefits	*$165,144,141*	*$88,685,238*	*$59,826,329*	*5,796,424*	*5,806,670*	*5,816,457*	*5,825,786*	*5,834,655*	*5,843,066*	*5,851,018*	*5,858,511*	*5,865,546*	*5,872,121*
Net Benefits	$159,852,191	$85,075,561	$56,996,682	4,512,759	5,623,005	5,632,792	5,642,120	5,650,990	5,659,400	5,667,352	5,674,846	5,681,880	5,688,456
BCR		83.8											
NPV/I		$82.8											
NPV/I k + op costs		$82.8											
Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.		$6											

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
OPTION 2 - SEA WALL - NO NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Benefits	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087
Net Benefits	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079
BCR																				
NPV/I																				
NPV/I k + op costs																				
OPTION 3 - PLANNED RETREAT																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillon																				
Cost of planning controls on 9 properties plus 71 properties	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*
	57	*55*	*54*	*53*	*51*	*50*	*48*	*47*	*45*	*44*	*43*	*41*	*40*	*38*	*37*	*36*	*34*	*33*	*31*	*30*
Benefits																				
Avoided Inundation damage	131,514	137,172	142,371	147,112	151,394	155,217	158,581	161,487	163,934	165,922	167,451	168,521	169,133	169,286	168,980	168,215	166,992	165,310	163,169	160,569
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Benefits	*5,878,238*	*5,883,896*	*5,889,096*	*5,893,836*	*5,898,118*	*5,901,941*	*5,905,306*	*5,908,211*	*5,910,658*	*5,912,646*	*5,914,175*	*5,915,246*	*5,915,857*	*5,916,010*	*5,915,704*	*5,914,940*	*5,913,716*	*5,912,034*	*5,909,893*	*5,907,294*
Net Benefits	5,694,573	5,700,231	5,705,430	5,710,171	5,714,453	5,718,276	5,721,640	5,724,546	5,726,992	5,728,980	5,730,510	5,731,580	5,732,192	5,732,345	5,732,039	5,731,274	5,730,051	5,728,369	5,726,228	5,723,628
BCR																				
NPV/I																				
NPV/I k + op costs																				

Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.

	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
OPTION 2 - SEA WALL - NO NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087
Net Benefits	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	- 2,534,079	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921
BCR																				
NPV/I																				
NPV/I k + op costs																				
OPTION 3 - PLANNED RETREAT																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillon																				
Cost of planning controls on 9 properties plus 71 properties	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*	*183,666*

	28	*27*	*26*	*24*	*23*	*21*	*20*	*18*	*17*	*16*	*14*	*13*	*11*	*10*	*9*	*7*	*6*	*4*	*3*	*1*
Benefits																				
Avoided Inundation damage	157,511	153,994	150,018	145,583	140,689	135,337	129,526	123,256	116,527	109,340	117,292	121,666	122,461	119,678	113,316	103,376	89,858	72,761	52,086	27,832
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	0	0	0	0	0	0	0	0	0	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000
Total Benefits	*5,904,235*	*5,900,718*	*5,896,742*	*5,892,307*	*5,887,414*	*5,882,061*	*5,876,250*	*5,869,980*	*5,863,252*	*11,256,064*	*11,264,016*	*11,268,390*	*11,269,185*	*11,266,402*	*11,260,040*	*11,250,100*	*11,236,582*	*11,219,485*	*11,198,810*	*11,174,556*
Net Benefits	5,720,570	5,717,052	5,713,076	5,708,642	5,703,748	5,698,396	5,692,585	5,686,315	5,679,586	11,072,399	11,080,351	11,084,724	11,085,520	11,082,736	11,076,375	11,066,435	11,052,916	11,035,820	11,015,144	10,990,891
BCR																				
NPV/I																				
NPV/I k + op costs																				

Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.

	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080
OPTION 2 - SEA WALL - NO NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087
Net Benefits	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921
BCR																				
NPV/I																				
NPV/I k + op costs																				
OPTION 3 - PLANNED RETREAT																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillon																				
Cost of planning controls on 9 properties plus 71 properties																				
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000
Total Benefits	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*
Net Benefits	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059
BCR																				
NPV/I																				
NPV/I k + op costs																				
Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.																				

	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
OPTION 2 - SEA WALL - NO NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000	$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*	*$10,314,166*
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	77,142,857
Total Benefits	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	84,922,944
Net Benefits	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	74,608,778
BCR																				
NPV/I																				
NPV/I k + op costs																				
OPTION 3 - PLANNED RETREAT																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillon																				
Cost of planning controls on 9 properties plus 71 properties																				
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*	*103,666*
Benefits																				
Avoided Inundation damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoide loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	-$71,742,857
Total Benefits	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	*11,146,724*	- *65,996,133*
Net Benefits	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	- 66,099,798
BCR																				
NPV/I																				
NPV/I k + op costs																				
Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.																				

	4%	7%	10%	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
					Wollongong populat	184,213							
						2.5							
		Sensitivity			HH	73685.2							
Assumptions													
Inundation					PV cost	$2,505,618							
Probability of event in 2011	0.01				PV of cost per hh	$34.00							
Probability of event in 2050	0.1				Annual cost per hh	$2.38							
Probability of event in 2100	1												
Consequence of event per property	70000		1	This relates to 0.2 to 0.5m of flooding . We dont known what level will be with sea level rise inundation									
Number of properties	71		1	80 already in FDCP which requires alts and rebulidng to have floor levels above certain heights - we dont know how many have done this									
Growth rate of development to avoid flood dar	0%			- but controls already exist so marginal cost and benefit only applies to the difference									
Erosion													

Thirroul surf club visitors pa	5000	1	
consumer surplus for surf club use	10	1	
Thirroul pool visitors pa	500,000	1	Implicity assume revenue covers operating costs so no loss of PS or cost saving - but probably a cost saving if it disappears.
cs for pool visitors	10	1	
Heritage site value per person per annum	0.01	1	
Aggregation to 79% of Aust hh	6,032,953	1	
open space around pool visitors pa	200000	1	Assumed net of maintenance costs
cs for use of open space	$10	1	
pavillion - restaurant producer surplus	600000	1	Assumed net of maintenance costs
pavillion - value as a residence - rent pa	30000	1	Assumed net of maintenance costs
Private properties no.	9	1	
Private property values	$2,000,000	1	
private discoutn rates	30%		

Maintenance costs	Asset value	Maintenance	
Pool	1300000	$20,450	
Other pool buildings	641532	$10,092	
Pavillion	2745498	$43,189	
SLSC	1693183	$26,635	
Reserve	112875	$8,800	
Beach		$3,300	
Total		$112,466	1

OPTION 1 - SEAL WALL - WITH NOURISHMENT

Initial beach nourishment (m3)	90000	1
Ongoing beach nourishment (m3)	30000	1
Cost per m3 of beach nourishment	25	1
Avoid Thirroul beach use lost	500000	1
Consumer surplus for beach use	20	1

OPTION 2 - SEAL WALL - NO NOURISHMENT

Capital costs / metre	$10,000	1
Metres	410	1
Mainenance costs pa	5%	1
Lost beach		
Annual visit days	500,000	1.00
$/visit day	20	1
SLSC asset value		
Maintenance costs		
Pavillion asset value		
Maintenance costs		
Pool asset value		
Operating costs including maintenance		
Thirroul Reserve area		
Maintenance costs		

OPTION 3 - PLANNED RETREAT

Relocation costs per tonne	1000	1	
Pavillion tonnes	250	1	
Pool tonnes	600	1	
SLSC	250	1	
Rate at which redevelopment happens	2%	1	160000
Number of properties	9	1	
No of inundation properties	71	1	
Value of properties	2000000	1	
private discoutn rates	30%		
Cost of DCP works per property	50000	1	

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Assumptions																				
Inundation																				
Probability of event in 2011																				
Probability of event in 2050																				
Probability of event in 2100																				
Consequence of event per property																				
Number of properties																				
Growth rate of development to avoid flood dar																				
Erosion																				
Thirroul surf club visitors pa																				
consumer surplus for surf club use																				
Thirroul pool visitors pa																				
cs for pool visitors																				
Heritage site value per person per annum																				
Aggregation to 79% of Aust hh																				
open space around pool visitors pa																				
cs for use of open space																				
pavillion - restaurant producer surplus																				
pavillion - value as a residence - rent pa																				
Private properties no.																				
Private property values																				
private discoutn rates																				
Maintenance costs																				
Pool																				
Other pool buildings																				
Pavillion																				
SLSC																				
Reserve																				
Beach																				
Total																				
OPTION 1 - SEAL WALL - WITH NOURISHMENT																				
Initial beach nourishment (m3)																				
Ongoing beach nourishment (m3)																				
Cost per m3 of beach nourishment																				
Avoid Thirroul beach use lost																				
Consumer surplus for beach use																				
OPTION 2 - SEAL WALL - NO NOURISHMENT																				
Capital costs / metre																				
Metres																				
Mainenance costs pa																				
Lost beach																				
Annual visit days																				
$/visit day																				
SLSC asset value																				
Maintenance costs																				
Pavillion asset value																				
Maintenance costs																				
Pool asset value																				
Operating costs including maintenance																				
Thirroul Reserve area																				
Maintenance costs																				
OPTION 3 - PLANNED RETREAT																				
Relocation costs per tonne																				
Pavillion tonnes																				
Pool tonnes																				
SLSC																				
Rate at which redevelopment happens																				
Number of properties																				
No of inundation properties																				
Value of properties																				
private discoutn rates																				
Cost of DCP works per property																				

	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
Assumptions																				
Inundation																				
Probability of event in 2011																				
Probability of event in 2050																				
Probability of event in 2100																				
Consequence of event per property																				
Number of properties																				
Growth rate of development to avoid flood dar																				
Erosion																				
Thirroul surf club visitors pa																				
consumer surplus for surf club use																				
Thirroul pool visitors pa																				
cs for pool visitors																				
Heritage site value per person per annum																				
Aggregation to 79% of Aust hh																				
open space around pool visitors pa																				
cs for use of open space																				
pavillion - restaurant producer surplus																				
pavillion - value as a residence - rent pa																				
Private properties no.																				
Private property values																				
private discoutn rates																				
Maintenance costs																				
Pool																				
Other pool buildings																				
Pavillion																				
SLSC																				
Reserve																				
Beach																				
Total																				
OPTION 1 - SEAL WALL - WITH NOURISHMENT																				
Initial beach nourishment (m3)																				
Ongoing beach nourishment (m3)																				
Cost per m3 of beach nourishment																				
Avoid Thirroul beach use lost																				
Consumer surplus for beach use																				
OPTION 2 - SEAL WALL - NO NOURISHMENT																				
Capital costs / metre																				
Metres																				
Mainenance costs pa																				
Lost beach																				
Annual visit days																				
$/visit day																				
SLSC asset value																				
Maintenance costs																				
Pavillion asset value																				
Maintenance costs																				
Pool asset value																				
Operating costs including maintenance																				
Thirroul Reserve area																				
Maintenance costs																				
OPTION 3 - PLANNED RETREAT																				
Relocation costs per tonne																				
Pavillion tonnes																				
Pool tonnes																				
SLSC																				
Rate at which redevelopment happens																				
Number of properties																				
No of inundation properties																				
Value of properties																				
private discoutn rates																				
Cost of DCP works per property																				

	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080
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Total																				
OPTION 1 - SEAL WALL - WITH NOURISHMENT																				
Initial beach nourishment (m3)																				
Ongoing beach nourishment (m3)																				
Cost per m3 of beach nourishment																				
Avoid Thirroul beach use lost																				
Consumer surplus for beach use																				
OPTION 2 - SEAL WALL - NO NOURISHMENT																				
Capital costs / metre																				
Metres																				
Mainenance costs pa																				
Lost beach																				
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$/visit day																				
SLSC asset value																				
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Pavillion asset value																				
Maintenance costs																				
Pool asset value																				
Operating costs including maintenance																				
Thirroul Reserve area																				
Maintenance costs																				
OPTION 3 - PLANNED RETREAT																				
Relocation costs per tonne																				
Pavillion tonnes																				
Pool tonnes																				
SLSC																				
Rate at which redevelopment happens																				
Number of properties																				
No of inundation properties																				
Value of properties																				
private discoutn rates																				
Cost of DCP works per property																				

	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
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Inundation																				
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Cost of DCP works per property																				

APPENDIX G: WOLLONGONG COASTAL EROSION EMERGENCY ACTION SUB PLAN

Wollongong Coastal Erosion Emergency Action Sub Plan

January 2012

Prepared For:	Wollongong City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Title:	Wollongong Coastal Erosion Emergency Action Sub Plan
Author :	Doug Lord (Coastal Environment Pty Ltd)
Synopsis :	This Wollongong Coastal Erosion Emergency Action Sub Plan forms an Appendix to the Wollongong Coastal Zone Management Study and Plan. This sub-plan outlines actions to be performed before, during and after an erosion emergency and the roles and responsibilities for coastal erosion emergencies.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
Appendix to Rev 3	02/12/11	VPR		VPR	
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DESTINATION	REVISION			
	0	1	2	3
WCC	1			
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CONTENTS

ACRONYMS

CEEAS	Coastal Erosion Emergency Action Sub-plan
CPA	Coastal Protection Act (1979)
DECCW	Department of Environment Climate Change and Water (former department, now OEH)
LEMC	Local Emergency Management Committee
LEOCON	Local Emergency Operations Controller
OEH	Office of Environment and Heritage
SERM	State Emergency and Rescue Management
SERMA	State Emergency and Rescue Management Act
WCC	Wollongong City Council

1 INTRODUCTION

1.1 Coastal Zone Management Planning

The process for managing coastal hazards and coastal risks along the New South Wales coast is through the preparation of Coastal Zone Management Plans. Through the development and subsequent implementation of these plans, the coastal hazards are identified and, as appropriate, the risks are addressed through a range of planning and protection measures. In this way the likelihood of emergencies resulting from erosion during storm events is minimised. The need for unplanned protection is reduced and the risk to life and property managed. The residual risk to properties, assets and life until such time as the key elements of the plan have been adopted or as a result of potential unforeseen outcomes or storm severity are covered by this Coastal Erosion Emergency Action Subplan (CEEAS).

The CEEAS is a required component of the preparation of a Coastal Zone Management Plan (CZMP) as set out in the NSW *Coastal Protection Act 1979* (the CPA). Section 55C(1)(b) of the CPA states a CZMP must provide for *'emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event'.* Section 4 of the CPA states that the part of a CZMP that deals with the matters specified in Section 55C(1)(b) is an emergency action sub plan (OEH 2011, page 1).

1.2 The Role of the Coastal Erosion Emergency Action Sub-plan

"The emergency action sub-plan forms an integral component of a CZMP. It outlines a council's intended response to a coastal erosion emergency and explains ways in which and where beachfront property owners can place emergency coastal protection works according to the Coastal Protection Act 1979 (CPA)" (OEH 2011, page 1).

"Section 55C(2)(a) of the CPA requires that CZMPs ***must not*** *include matters dealt with in any plan made under the State Emergency and Rescue Management Act 1989 (SERMA) in relation to emergency responses.*

The roles and responsibilities of government agencies, councils and other relevant organisations during severe storm events (including events that cause erosion) are detailed in the NSW State Storm Plan (SES 2007)" (OEH 2011, page 1).

1.3 Extent of the Coastal Erosion Emergency Action Sub-plan

The OEH Guide (2011) advises that *"The minimum area to be covered by an emergency action sub-plan would be either:*

- *any area defined by a direction from the Minister according to Section 55B of the CPA; or*
- *all beachfront margins where erosion is likely to threaten public and private infrastructure or assets.*

The sub-plan may also cover areas of the coastline accessed or utilised by the general public where there is an identified threat posed by erosion, e.g. walking tracks through coastal parkland."

No direction has been issued under Section 55B for the Wollongong Local Government Area (LGA) coastal zone. The extent of this CEEAS is, therefore defined as the coastal margins of the ocean beaches and headlands within the city boundaries, extending from the Royal National Park at Stanwell Park in the North to the Lake Illawarra entrance in the south (excluding the Port Kembla Harbour foreshores).

1.4 Minimum Requirements for Emergency Action Sub-plans

The CEEAS must be consistent with and not duplicate or contradict any plans prepared under the *State Emergency and Rescue Management Act 1989* (SERM Act). The relationship between these two planning frameworks is indicated in Table 1 which has been adapted from OEH, 2011 (page 14).

Table 1 Contents of CEEAS and SERM Act plans (adapted from OEH, 2011)

Emergency Action Sub Plans	SERM Act Plans
Any coastal protection works or other actions to be carried out by council when coastal erosion is imminent or occurring, or in recovering from coastal erosion.	Actions in relation to the prevention of, preparation for, response to and recovery from emergencies, excluding permanent or temporary coastal protection works.
Any additional requirements for landowner placement of emergency coastal protection works beyond those in the *Coastal Protection Act 1979* (e.g. constraints on access and the location of works) *	Actions are consistent with the NSW State Disaster Plan and the State Storm Sub Plan.

** No locations for emergency coastal protection works in accordance with the CPA 1979 have been identified in the Wollongong LGA coastal zone.*

Where landowners are eligible to place emergency coastal protection works, the CEEAS is to be prepared with direct consultation with landowners affected by the subplan. In the Wollongong LGA coastal zone at present there are no private properties identified as eligible to place emergency coastal protection works in accordance with the CPA 1979 (Part 4C). Therefore, this requirement is not currently applicable.

The minimum requirements for a Coastal Erosion Emergency Action Subplan are set out in the NSW Government Guideline (OEH, 2011) which reflects the requirements expressed in the CPA 1979. These are:

- describing intended emergency actions to be carried out during periods of beach erosion, such as coastal protection works for property or asset protection, other than matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* relating to emergency response (sections 55C(1)(b) and (g) of the CPA *1979*)
- describing any site-specific requirements for landowner emergency coastal protection works
- describing the consultation carried out with the owners of land affected by a subplan.

2 EMERGENCY PLANNING HIERARCHY

2.1 Declared Storm Emergency

There is a clear hierarchy in planning and responsibility that applies to emergency management in NSW, including those emergencies resulting from a defined storm or disaster. In these events, the NSW State Emergency Services are designated as the lead combat agency and are in charge of the emergency response. The various roles and responsibilities are defined in the NSW Storm Plan and within the City of Wollongong Local Disaster Plan (DISPLAN). The DISPLAN states at paragraphs 114 and 115 that:

"***114*** *Subject to the requirements and provisions of the SERM Act, and under the provisions of the SES Act, for the emergencies of flood and damage control for storms, including the coordination of evacuation and welfare of affected communities, the overall control of operations in response to these emergencies is vested in the Director General of the State Emergency Service.*

115 *In both flood or storm emergencies, the DISPLAN for the District and/or any Local Area to which the emergency applies is automatically active and Police, the other Emergency Services and Functional Areas are to provide support as required by the Combat Agency Controller. The Local or District Emergency Operations Controller is then to be prepared to coordinate support if requested by the appointed Local/Division State Emergency Service Controller*."

Therefore, the Wollongong DISPLAN informs this Coastal Erosion Emergency Action Sub-plan.

The role of Council in a storm emergency is limited to those activities that may be requested by the SES to assist with the emergency relief or to activities (including protection works) undertaken by the Council to protect assets under Council control. Where any proposed protection works require development approval, Council must only undertake such works during an emergency where the consent has been obtained in advance. Where the works are exempt (such as minor works or emergency works to protect a road or stormwater system under SEPP (Infrastructure) 2007) Council must first undertake an assessment to determine that the works will not result in a significant adverse environmental impact. Before undertaking any works, Council must also confirm that the works proposed are in accordance with the currently gazetted (or adopted) Coastal Zone Management Plan.

There are no protection works proposed for emergency management purposes under this CEEAS that require development consent.

Following the emergency, Council is involved in the remediation of damage or hazards and the reinstatement of the dunes, beaches and accessways in an appropriate and safe manner. This will include works of varying priorities and timeframes in accordance with usual Council maintenance procedures.

2.2 Coastal Erosion Emergency (not triggered by a storm)

Where the erosion emergency arises from events other than a declared storm event, then the requirement of the State Storm Plan and Wollongong DISPLAN are not activated. Such an event could arise for example from a period of high tides and large swell, resulting in substantial erosion to the back of the beach. For these conditions it is likely that the erosion resulting would be substantially less than that which would result from the design storm event (unless such an event was to occur immediately following a severe storm event).

It is not possible to determine a trigger event for such an occurrence. Therefore, the determination to invoke the this emergency sub-plan (in this case by Council) would need to be based on monitoring of the beach state. In such a case, the CEEAS would be implemented following a request from the designated Council Officer.

2.3 Assets and Development at Threat

The extent of coastal hazards within the Wollongong LGA coastal zone is defined in the Wollongong City Council Coastal Zone Study (Cardno, 2010). This study maps the landward extent of erosion hazards that may be anticipated for various planning timeframes. Specifically, the landward extent of erosion hazards at present are defined in Maps included in the Wollongong Coastal Zone Study (Cardno, 2010) at Figures 8.5 to 8.13 and form the basis for defining the extent of the erosion hazard at present.

Within the Wollongong LGA coastal zone the extent of storm erosion resulting from a severe design storm event at present is mainly restricted to the sandy beach area with little public infrastructure or private property likely to be affected. Significant encroachments of the storm erosion extent threatening existing development are limited to the following locations:

- the parking area and ramp at Austinmer Boat Harbour (Cardno, 2010 Fig 8.5);
- the seaward portion of the Tuckerman Park carpark at Austinmer North (Cardno, 2010 Fig 8.6); and
- Thirroul Beach carpark and promenade (Cardno, 2010 Fig 8.7).

At each of these locations the development likely to be impacted is protected by a seawall of unknown design. The potential encroachment of the erosion into these paved areas was calculated on the basis that the seawall at present offered no protection to beach erosion.

In addition to these specific developments there are different types of activities, development and areas that may be impacted during an erosion emergency. These include:

- stormwater and drainage outlet structures located on beaches;
- ocean baths and rock pools;
- defined beach and dune access tracks under care and control of Council; and
- the beaches and dunes.

These exist within an area of known high hazard and are either designed to accommodate the erosion events (such as the stormwater outlets and pools), or are temporarily affected by erosion, limiting their use by the community (such as beaches and accessways). In each case the opportunity to protect the asset prior to an erosion event is low and the risk to life during an event is low. Similarly, the opportunity to undertake emergency works during an event is low and the preferred approach is to identify impacts, assess and repair the asset following the event. In most instances this becomes a routine maintenance role.

The landward extent of the erosion hazard as considered in this CEEAS may increase into the future as sea level rises. The impacts on the future revisions of the CEEAS should take this into account at each plan review.

3 EMERGENCY RESPONSES

3.1 Communication

3.1.1 Storm Emergency

Where coastal erosion is anticipated as a result of a declared storm emergency, the responsibility for communicating the potential hazards defaults to the SES and the Local Emergency Operations Controller (LEOCON). Activation of the Wollongong DISPLAN would trigger this CEEAS. Council would assist in the provision of information on the current state of beaches and ocean pools as well as potential for impacts on beach access. Internally, Council staff with relevant responsibilities should be placed on standby and commence monitoring the impacts. Council employed Lifeguards and local Surf Life Saving Clubs should be contacted with a view to closure of beaches and ocean pools.

As the emergency progresses Council is required to continue monitoring these areas and updating information through the LEOCON as appropriate. Where specific hazards are resulting in damage, Council will provide this information to the LEOCON and for distribution through the media or directly to community as appropriate.

Following the emergency, Council is responsible for advising the current state of beaches and pools in the Council area (when/if they are re-opened for the public). Where residual hazards remain to be addressed, Council should take appropriate action to convey this to local communities including the use of signage and the release of media bulletins.

3.1.2 Non Storm Erosion Emergency

Where the emergency does not trigger the State Storm Plan or Wollongong DISPLAN, Council is responsible for initially monitoring the potential progress of erosion and subsequently implementing this CEEAS. The roles and responsibilities of Council in communicating the emergency to the community remain the same except that information needs to be provided by Council directly through the media rather than through the LEOCON as outlined in Section 3.1.1 above.

3.2 Landowner Initiated Actions

There are no locations in the Wollongong LGA coastal zone at which temporary emergency coastal protection works (CPA 1979, Part 4c Sand/Sandbags ECPW) are permitted. This includes properties within the immediate erosion hazard line in the LGA, such as at Thirroul Beach. Temporary emergency coastal protection works are only permitted under the CPA 1979 at locations listed in Schedule 1 of that act, none of which exist in Wollongong LGA.

Property owners, such as those at locations within the immediate erosion hazard line, are permitted to submit development applications to install permanent protection works, provided such works are consistent with the Wollongong CZMP once it is certified.

Where property owners wish to install permanent protection works (either prior to or during a coastal erosion emergency):

- they must submit a development application for the works,

- they must have a valid approval, and
- they must comply with all conditions of consent applying to that approval, before proceeding with the works.

Any illegal works placed by a property owner may result in prosecution of the person and removal of the works.

A property owner may be able to undertake minor works to minimise damage to their property and/or dwelling where such works do not require development approval and do not result in adverse impacts. The types of things permitted without consent are unlikely to provide significant protection from any coastal erosion that is occurring but may limit consequent damage, for example: Sealing of the space at the bottom of a doorway to limit water entry, repair/replacement of damaged windows, cladding or roofing, clearing of drains, pumping of ponded water, removal of objects from proximity to an escarpment (such as fences, sheds, furniture), etc.

The owner of a property has the right to undertake a wide variety of activities/maintenance in relation to their property which may or may not result from damage during a storm event and which, generally are of a minor nature. As with all activities there is a common law obligation not to cause a nuisance to neighbours or damage to adjacent properties. Generally those works resulting in structural alterations to a building (de including demolition or removal), or significant construction (such as a retaining wall or underpinning a structure) or significant earthworks (excavation or placement of fill) would require prior development/building approval.

3.3 Council Actions Prior to a Coastal Erosion Emergency

- Where the likelihood of an emergency event is identified (e.g. Storm warnings or damaging wave warnings from the SES/BOM), the local Lifeguards (employed by Council) will inform the local Surf Life Saving Clubs. The Council Lifeguards and / or the local SLSCs will then take the appropriate action in terms of closing the beaches and/or ocean pools.
- Where difficulties/damage are known to exist on beach accessways and these are likely to be exacerbated by storm erosion, then Council at their discretion may close those walkways and place appropriate signage.
- Council will commence monitoring the effects of the erosion on assets and development potentially at threat (section 5).
- As appropriate, the Council CEEAS controller will initiate the CEEAS.

3.4 Council Actions During a Coastal Erosion Emergency

The following activities would be undertaken by Council during the emergency:

- Council activities during a coastal erosion emergency will be guided by issues relating to the safety of Council staff.

- Where damage to walkways is identified and/or reported to Council, as practical Council will take appropriate action to close off the accessways and/or advise the local community of the hazards at the first opportunity.
- Where damage to assets is identified through monitoring (Section 5), Council will assess the damage and any opportunities for limiting further damage that may be appropriate during the event.
- Where repairs are permissible (as outlined in Section 2.1) and may be readily and safely undertaken, this will be done at the first opportunity.
- At the appropriate time the CEEAS controller will determine that the emergency has passed and that the remediation stages of the plan are to commence.

3.5 Council Actions Following the Cessation of a Coastal Erosion Emergency

The following activities would be undertaken by Council following the emergency, within their usual maintenance programs.

- Following the erosion emergency, Council will undertake an inspection of all beach accessways to establish any damage to the access or dangers to the public in using the access to the beach.
- Where an accessway is considered unsafe, action will be taken to close the access (top and/or bottom) and to place appropriate signage warning the access is unsafe for use.
- Council will prioritise the work required to repair and reopen any damaged or unsafe accessways in accordance with the Council maintenance works schedule.
- Where an erosion escarpment has been created at the back of the beach (height greater than 1.5m), Council will document the extent of the escarpment and at the earliest opportunity undertake a risk assessment of the likely hazard to beach users (both to persons on the beach and to persons on the dune above the scarp) from collapse of the erosion scarp.
- Where the risk is deemed unacceptable, Council will at the earliest opportunity undertake appropriate mitigation works which may include:
  - regrading the escarpment to a stable slope (following approval from Council's environment division);
  - fencing and signposting escarpments, to discourage public access (top and/or bottom) until such time as the beach recovers naturally; and
  - keeping the beach closed until such time as the risk has reduced to an acceptable level.
- At the appropriate time the Council CEEAS controller will declare the emergency has finished and the CEEAS is no longer operative.

4 RESPONSIBILITIES

Specific responsibilities under the CEEAS are tabulated in Table 2.

Council through the nominated CEEAS controller must tabulate relevant Council positions and responsibilities for implementation and execution of the CEEAS. This will require an up to date list (names and contact numbers) for relevant contacts to be maintained by Council and updated as positions or responsibilities change. This list is to be readily available within Council and communicated to each of the nominated contact persons following any update.

Table 2 Specific Responsibilities in implementation of the CEEAS

Position	Responsibilities
Local Emergency Operations Controller (LEOCON)	Execution of the Local DISPLAN, including aspects relating to coastal erosion
Council CEEAS controller	Liaison with LEOCON during storm emergency. Implementation of the CEEAS during non-storm erosion emergency
Council Recreation Services Manager	Monitoring repair of beaches and dunes. Closure of Beaches and ocean pools as appropriate. Post storm remediation.
Council Media Liaison Officer	Distribution of warnings and closures via the media.

5 PLAN REVIEW

This coastal erosion emergency management plan should be maintained as required and reviewed at intervals not exceeding 5 years from its initial adoption. Earlier review may be triggered by:

- occurrence of a coastal erosion emergency that exceeds the defined hazard extent as outlined in the Wollongong City Council Coastal Zone Study (Cardno, 2010) to redefine the extent of the area covered by the Plan;
- revision of the NSW State Storm Plan, the Local DISPLAN (revised each five years) or the Coastal Protection Legislation and associated guides, to ensure the plan remains consistent with their objectives;
- unsatisfactory outcomes or concerns following a coastal erosion emergency; or
- proposed changes to the gazetted Coastal Zone Management Plan.

6 REFERENCES

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