

## Light Years Ahead: The Role of Design, Survey and Land Management in Disaster Risk Management and Future-Proofing Adelaide

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**Key words:** Spatial planning, Risk management, Historical surveys, Land management

### SUMMARY

Colonel William Light, South Australia's first Surveyor-General, designed a remarkable spatial layout for the District of Adelaide with great resolve, against concerted opposition. Withstanding sustained attack for his site selection and separation of the City and Port of Adelaide, he applied experience gained during military service in the British Royal Navy and as a reconnaissance officer and Deputy Assistant Quartermaster General in Wellington's Army in the Iberian Peninsula. Modern scientific modelling indicates Light's determination to place urban form on rising ground clear of areas liable to inundation future-proofed the City, guarding it from disasters such as dambreak and probable maximum flood. Providing ongoing benefit and inspiration, his sustainable framework set a benchmark for disaster risk management more than one and a half centuries before the *River Torrens Flood Inundation Mapping Study* recommended identical measures to reduce future flood damage. This paper considers Light's disaster risk minimisation design methodology, trigonometrical survey establishing the District's spatial layout, and details of the original triangulation of the Adelaide Plains, watercourses, reserves and Port Adelaide River.

### SUMMARY (FRENCH)

Le premier arpenteur général de l'état d'Australie-Méridionale, le colonel William Light, a connu avec fermeté un remarquable plan de division foncière du district d'Adélaïde, malgré une opposition concertée. Résistant aux critiques dénonçant le choix du site de la ville d'Adélaïde et sa séparation de la zone portuaire, ses travaux d'arpentage bénéficiait de l'expérience militaire acquise au sein de la Marine royale britannique et à titre d'officier de reconnaissance et de quartier-maître général adjoint dans l'armée de Wellington lors de la Guerre d'indépendance espagnole. Aujourd'hui, la modélisation scientifique permet de mettre en évidence la détermination de Light à localiser les zones urbaines sur des terres surélevées à l'abri des inondations, permettant ainsi de protéger la ville face aux risques de désastres futurs comme la rupture d'un barrage ou la crue maximale des eaux. Source de bénéfice et d'inspiration continue, son système de division foncière établissait le point de référence pour la gestion durable des risques de désastres, plus d'un siècle et demi avant que les études cartographiques des inondations de la rivière Torrens ne recommandent des mesures similaires visant à réduire les dommages consécutifs aux inondations. Cet article examine la méthodologie développée par Light pour planifier la minimisation des risques de désastres, les levés trigonométriques établissant la division foncière du district d'Adélaïde, et les particularités de la triangulation originaire de ses plaines, cours d'eau, réserves et zone portuaire.

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## 1. INTRODUCTION

The first recorded earthquake in Adelaide, South Australia, occurred at 4.25am on Sunday 22 July 1837 and lasted about 20 seconds with ‘a loud and deep noise resembling the rattling over paved streets of a train of heavy waggons or artillery’ that seemed to come from hills to the north-east and pass off in a SW direction – the natives recalled two similar shocks many years before (*South Australian Gazette and Colonial Register* 29 July 1837:3; Dix 2013). In the months before the earthquake, South Australia’s first Surveyor-General Colonel William Light had planned the City of Adelaide, the Town Acres had been surveyed and purchasers had selected their town land. Although there is no evidence of design precautions to guard against earthquakes, Light’s diary (Light 1839), along with contemporary sketches and plans record deliberate actions he took to protect the city from flooding. He distanced it from the coast and wetlands, avoided riverbank areas he had identified as liable to inundation (Elder 1984), and carefully placed Adelaide’s town sections and reserves for public buildings, such as a hospital, on higher ground clear of the River Torrens and its floodplain. Light’s design methodology minimised Adelaide’s risk of flooding, unlike later South Australian towns and Edward Jollie’s plan for Christchurch, New Zealand—also laid out on both banks of a river.

South Australia was founded on principles proposed by Edward Gibbon Wakefield, Benthamites and colonial reformers, and implemented by Colonization Commissioners who authorised Light to site, design and survey the capital city. Significantly, Light was delegated sole responsibility for making initial land use and spatial planning decisions that government had no power to over-ride. This resulted in a remarkable environmentally sensitive urban layout, unique in the world. More recently, Light’s planning legacy has been squandered, demonstrating issues that arise when politicians dictate unsustainable changes in land use and management contrary to basic principles of natural disaster mitigation.

In recent times Kötter has advocated a settlement structure that supports prevention of environmental hazards and mitigates negative effects (Kötter 2013:4), also stating that settlement transitioning from ‘compact’ to ‘network’ town is development that is ‘not sustainable from an economical and ecological point of view’. An FIG Report (2006, referring to Friesecke 2004) states a key non-structural disaster management strategy for flood prevention is to leave more room for rivers, particularly for their natural flood plains, or to give space back to them. Modern construction of a new Adelaide hospital—one of the most complex building infrastructure projects to be delivered in Australia—has incorporated lessons learnt in Christchurch from recent earthquakes (McBean 2013:9). However, invading the River Torrens valley with such massive constructions ignores

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benchmarks for sustainability and risk minimization set by Light with his 1837 vision for preserving the River Torrens valley as open space in perpetuity.

## 2. SOUTH AUSTRALIA'S 'SURVEY BEFORE SETTLEMENT' CHARTER

South Australia is a rare example of a Province established by Parliamentary Charter, and the first practical test of Wakefield's theory of Systematic Colonisation. Unlike American colonies, South Australia's founding principles were embodied in an Act of the British Parliament, 4 & 5 Wm IV c.95, which empowered Commissioners to carry out land sales and emigration, and removed land management control from government. According to South Australia's first Colonial Secretary, Robert Gouger, although this didn't guarantee good government, one means of corruption was thereby removed (Gouger 1838). Key principles outlined by English Philosopher Jeremy Bentham in his 'Colonization Society Proposal' included 'concentration-maximising-dispersion-preventing', and 'the greatest good' (Bentham 1831). South Australia's land was to be managed on entirely new principles, addressing evils experienced: dispersed / low density colonial settlement, poor urban health (industrialisation and lack of green space) and government mismanagement of Crown lands (Wakefield 1829, 1833; Napier 1835; Torrens 1835). The South Australian Colonization Commissioners were required to declare the Province's land to be 'Public Lands' available for sale in fee simple absolute with no reserve in the Crown whatsoever, and ensure survey before settlement.

The Commissioners delegated their powers for site selection, planning and survey of a permanent capital to William Light, whom they appointed as Surveyor-General and Leader of their 'First Expedition' to South Australia. To preserve public access to navigable waters, Light's instructions required a coastal reserve of all land within not less than 100 feet of the high-water mark, and 66ft reserves along each side of every navigable river (South Australian Colonization Commission 1836:Instruction 19). As Light planned the River Torrens to be navigable within the City of Adelaide (between Hackney and Hindmarsh), he provided a 66ft reserve along both banks. The Commissioners' instructions gave high priority to 'a commodious harbour, safe and accessible at all seasons', 'fertile land', 'abundant supply of fresh water', 'facilities for communication' (internal and with other ports), and proximity to 'extensive sheepwalks' (South Australian Colonization Commission 1836; Elder 1986:126-127). Facilities 'for drainage' were of secondary importance but no specific instructions were given for precautions against flooding. The Commissioners were confident Light would carry out his tasks so as to achieve the best possible result and 'purposely avoid[ed] all minute instruction', leaving Light 'at liberty to deviate' from their general instructions.

Assistant Surveyor Boyle Travers Finniss credited Light's mature judgment in assessing South Australian sites for settlement to his service in the Peninsular War (Finniss undated:24). From 1808 to the 1820s Light had served in the British Army, rising from a cavalry cornet to Brevet Major (his rank of Lieutenant-Colonel was from later service in the Spanish Constitutional cause). Most notably, under Wellington in the Peninsula (1809–1814), Light gained valuable experience in reconnaissance and route surveys (Mayo:195–199). In particular, from November 1811 he served as Deputy Assistant Quartermaster General, carried out a crucial route survey of Portugal's northern

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Tras os Montes region to discover a viable third route of march for Quartermaster General George Murray, reconnoitered crossings of the Esla and Ebro rivers for the 1813 campaign's advance to Vitoria (Spain), and explored and mapped an area west of Pamplona for cavalry cantonments (Henderson 2016). Light's Peninsula War experiences included a multitude of rivers, watercourses, riverbank encampments and route assessments for infantry, cavalry and artillery. Fords, propensity for flooding, dangerous and rapid water-level changes and their impacts on movement and accommodation of large bodies of men, including delay, death and disease, were ongoing strategic and logistical considerations. In late 1809, Light witnessed many deaths attributable to the fever-ridden Guadiana River on the Spanish-Portuguese border, where there were over 500 deaths each month (Bamford). In cavalry cantonments, he spent several months in Portugal's flood-prone Mondego river valley (Figure 1) and experienced the inundation of Montemor-o-Velho's market place, having to negotiate flood waters and move stabled horses to higher ground (Henderson 2014). Prior to creation of the artificial Torrens Lake and riverbank high-rise construction, Adelaide's distance from the bed of the River Torrens was more reminiscent of Montemor-o-Velho's setback from the Mondego River (Figure 2).



Figure 1: Mondego River valley, view from the south (left) bank to the castellated town of Montemor-o-Velho, Portugal.



Figure 2: View from the Torrens Weir, River Torrens Lake to (South) Adelaide.

### 3. DISTRICT OF ADELAIDE TRIGONOMETRICAL SURVEYS

#### 3.1 Selection and survey of the town site

On 11 January 1837 the City of Adelaide survey commenced from Trig Station A in (South) Adelaide, set back from the Para Plateau escarpment edge at the corner of North and West Terraces, which were designed to be 150 feet wide (Figure 3).

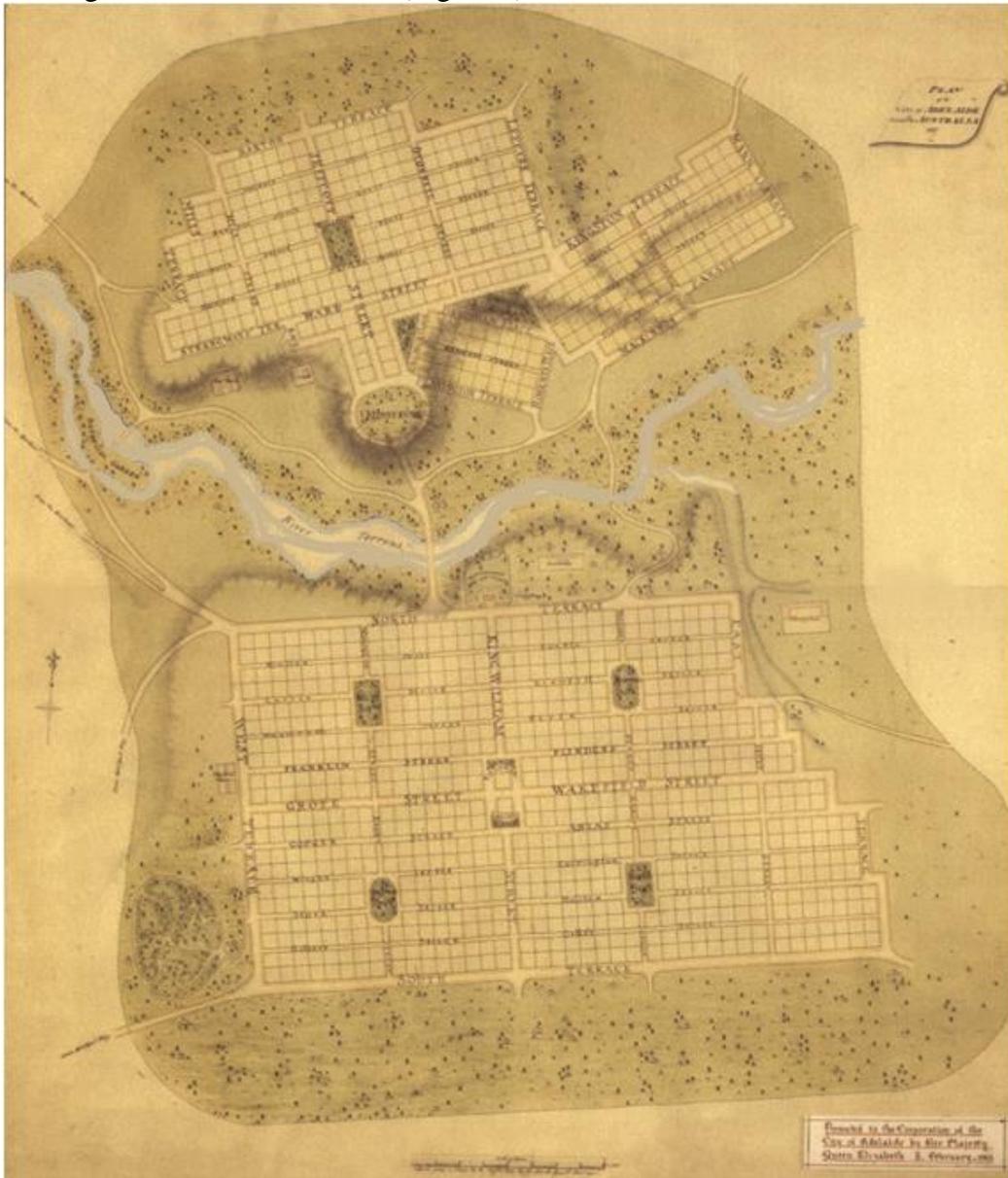


Figure 3: *Plan of the City of Adelaide, South Australia, 1837. Copied from a Plan by W Light Esq by W Jacob Assist[an]t Surveyor. Presented to the Corporation of the City of Adelaide by Her Majesty Queen Elizabeth II. February, 1963. City of Adelaide Archives, Civic Collection CC001383.*

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Speculation about Adelaide having been planned by Light's deputy, George Kingston, is completely rebutted by eye-witnesses and contemporary sources. The town survey was finished on 10 March, after 14 days delay in which Assistant Surveyors Finnis and George Ormsby had to re-survey sections west of King William Street described as '*so wretchedly executed [by Kingston] that Colonel Light found it would take more time to correct Mr. Kingston's blunders than to survey it again.*' Everyone knew Kingston was '*totally ignorant of surveying, theoretically or practically*' (*South Australian Gazette and Colonial Register*, 16 June 1838:2). Except for 29 Town Sections purchasers chose to select at Port Adelaide (Figure 4), Town Acres were selected in the City of Adelaide on 23 March. Light's care in setting Adelaide's land parcels well clear of the river with wide terraces and streets contrasts with Edward Jollie's 1850 Christchurch plan (Figure 5), where Captain Joseph Thomas required narrower roads and allowed land parcels to be set on low-lying land.



Figure 4: Detail of 'Plan of the District of Adelaide Showing the Property of the South Australian Company', Light, Finnis & Co. Octr. 1838'. Shows watercourses, low-lying land, and SA Co. Town Sections (in red) at the port (left), and city (right). State Library of SA, MLSA BRG42/120/17.

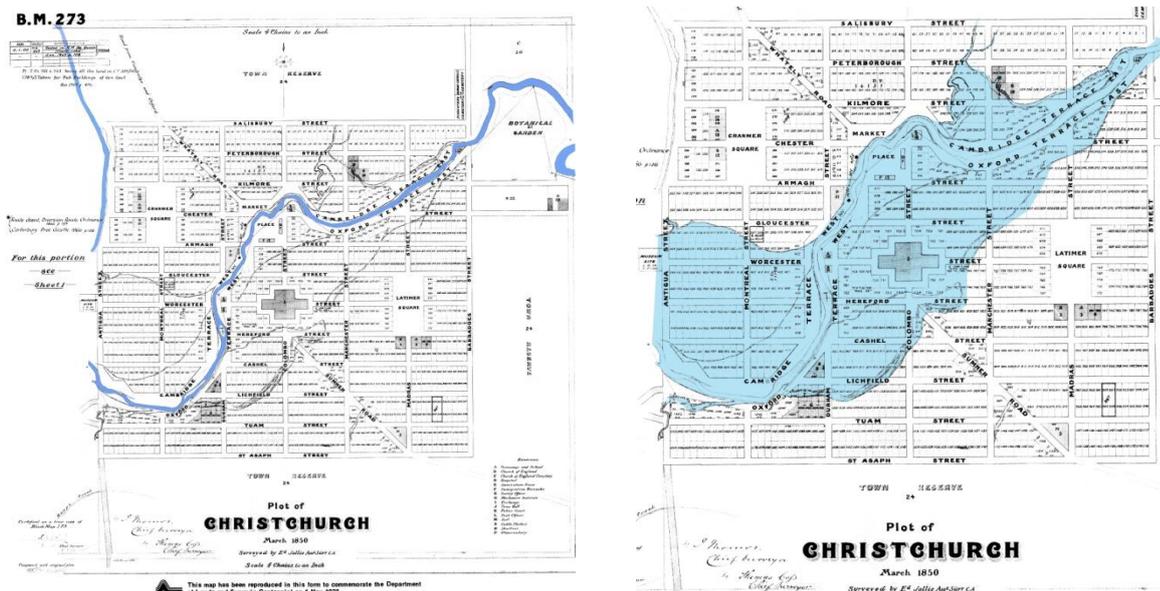


Figure 5: (left) Detail of Plot of Christchurch March 1850 by Edward Jollie, reproduced by Department of Lands and Survey, 1 May 1976, showing the River Avon (blue) (right), and overlay of low-lying land (right, K Henderson, 2016) identified by Jollie on BM273 (over 400 land parcels).

Town planners have tended to focus on the City of Adelaide and its Park Lands, however Light's task was far more complex and on a regional scale, keeping in mind desired future connection with the River Murray. Subsequent survey and selection of Country Sections (Figure 6) depended on the town site chosen, requiring on-site design of an initial 134-acre land parcel subdivision that preemptively reserved a district transport network and allowed purchasers' free, and hence unpredictable, selection, and complicated by the requirement for subsequent 80-acre subdivision of unselected land. Light's seamanship and navigational experience, largely ignored by academics, were crucial in assessing 1500 miles of coastline to choose the best site for an agrarian settlement with a mercantile harbour safe for lading cargo in all seasons (Light; Mayo; Dutton & Elder), and inspired his innovative co-ordinated cadastre (Porter 2007). John Porter's *South Australia's Shining Light—First Surveyor-General William Light* (2010) and *Light's Survey of Adelaide—facts, fables and fancies* (2007) remain the best analyses of Light's design decisions and survey methodology and implementation.

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Figure 6: Plan of the District of Adelaide Showing the Property of the South Australian Company, Light, Finniss & Co. Stephens Place [Adelaide]. Octr. 1838. SLSA MLSA BRG42/120/17

### 3.2 Topographical genius: flood & drought risk minimisation

Observing ‘frequent showers’ on Mt Lofty ‘even in the months of November and December, gave [Light] a certain proof that here we stood in no fear of those droughts so much complained of in New Holland’ (Elder 1984:99) and he believed a water supply for a larger population could be secured with dams in the foothills. Light paid particular attention to the Para Plateau, River Torrens floodplain and river valley, and watercourses to the east and south. The misleadingly named [South] ‘Park Lands Creek’ did not appear on Light’s maps as it is a subsequent man-made stormwater

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drain, not a natural watercourse. On examining up and down the River Torrens, Light saw ‘evident marks of the river overflowing its banks and this made [him] resolve on the first site [he] had chosen’ (Elder 1984: 92). He positioned the City with precision on the higher ground of the Para Plateau and reserved the River Torrens valley as open space Park Lands, deliberately guarding against floods of which he and the settlers saw ample evidence:

*... anyone can not have failed to remark the peculiar action of mountain torrents along the whole line of the river. Reeds are forced or jammed high up in the branches of immense trees which border the river banks, indicating ... recent floodings. The banks of the river above and below the town bear marks of upwards of 20 feet above ordinary level ... during the rainy season last year, the river rose in some of the narrow defiles upwards of 12 feet ... (Parsons 1982: 22).*

The beautiful inland site, and the harbour’s swampy land, and lack of fresh water had resulted in Light deciding against placing the city on the Port River, however some merchants insisted on taking town Acre sections there. Before these were selected, Light’s detailed survey of the Port Adelaide River landing place set out the Canal and mapped sinuous mangrove creeks to its north (Tam O’Shanter Creek) and south. The landing place chosen by Light, as a temporary measure, was the closest approach then possible to ‘the first rise of sandhills which affords some footing and protection against tide and danger of flooding’ (Parsons 1982: 21).

### **3.3 Country Sections Survey**

According to Porter, Light was considered watercourse crossing points in determining road alignments (Porter 2010). Prior to land parcel subdivision, Light fixed major diagonal transport connections to the landing places—the roads to Holdfast Bay and Port Adelaide (now known as Anzac Highway and Old Port Road)—by carrying out a trigonometrical survey of the District of Adelaide (Figure 6). This commenced on 2 May 1837 with the setting out of the line south (West Terrace) from the starting point at Trig Station A (Figure 7).

According to Light’s testimony, by 23 December 1837 the District survey had been carried to an extent of 60,000 acres. By 20 February 1838, over 100,000 acres had been surveyed, and complete ‘plans of such surveyed lands [were] preparing with all possible expedition’ (*South Australian Gazette and Colonial Register* 10 March 1838:2). A few days later a map had been completed of at least 60,000 acres surveyed near the town, but the Resident Commissioner James Hurtle Fisher expected a map of 120,000 acres would be available soon after 20 March (*South Australian Gazette and Colonial Register* 24 March 1838:3).

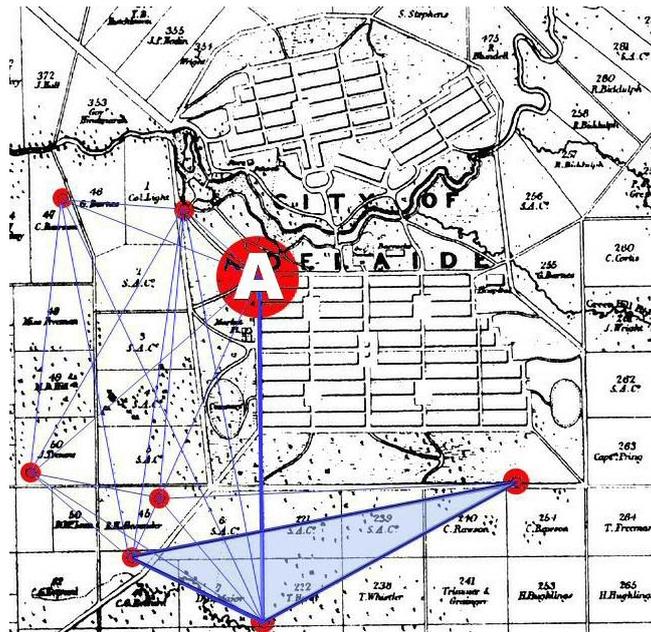


Figure 7: Detail of *The District of Adelaide, South Australia as divided into Country Sections from the Trigonometrical Surveys of Colonel Light, late Surv<sup>r</sup> Gen<sup>l</sup> John Arrowsmith, 1839. Overlaid with a sample trig station network, K Henderson, 2015.*

Light stated the quantity of land surveyed and mapped down was more than required for preliminary land owners, about 105 square miles: 69,000 acres around the Town, 27,000 acres at Rapid Bay, 5,400 at Yankalilla, about 20,000 at Kangaroo Island, and in a short time a further 28,000 acres could be done of the Onkaparinga plains. On 20 February, a meeting to decide the order in which Preliminary Country Sections would be selected resolved to use the same two-box ballot system as for the Town Acre selections, at a subsequent meeting to be held on 1 March (*South Australian Gazette and Colonial Register* 24 Feb 1838:2).

In early March, an injunction (subsequently dissolved) and action in the Supreme Court delayed Fisher allowing selection of Country Sections. Selections were eventually carried out on 12, 15 and 17 May. Only 218 (half, or upwards of 29,000 acres) of the preliminary selections were made. A further eight were reserved for choice in the District of Adelaide, eight for country between Adelaide and Onkaparinga (District B), sixty-nine for the districts of Yankalilla and Rapid Bay, forty-four for Encounter Bay, ten for Cape Jervis, fourteen for Kangaroo Island, and the remainder belonged to absentees who had lost their order of choice.

#### 4. LIGHT, FINNISS & CO.

On 5 June 1838 Light was the ‘talented and esteemed guest’ of honour at a public dinner, lauded for his extraordinary exertions in the survey and described as ‘everything that was honourable, everything that was gentlemanly, coupled with extraordinary talents’ (*Southern Australian* 16 June:4). Two weeks later the Commissioners’ despatches, arriving on the *Rapid* (19 June) shortly

before Kingston's return, ordered Light to expedite the Country sections survey (if not already completed) by a running survey of 150 square miles, and threatened Light with suspension (in favour of Kingston) if he refused to do so. Light refused instantly, describing it as 'no survey at all' and formed the private company of Light, Finniss & Co, with Finniss, Nixon and Jacob and RG Thomas. On Light's resignation, 11 survey officers gave their notice (2 July).

At a meeting of Land Proprietors on 10 July (continued from the day before) Fisher exhibited a finished Map of the Trigonometrical Survey of 65,000 acres around Adelaide, demonstrating the value of what Light and his survey team had already achieved (*Southern Australian* 14 July 1838:3).

#### **4.1 Port Adelaide Harbour Survey**

The Harbour Survey Company formed and employed Light to carry out a trigonometrical survey of the Port Adelaide River. Between 30 August 1838 and 1 October he fixed stations, measured baselines and took bearings, using moored ships such as the *Rapid*, [*Henry*] *Porcher*, *McCarthy*, *David*, [*Lady*] *Wellington*, *Eden* and [*Duke of*] *Roxburghe*.

Criticism of Light's choice of the first Port River landing place ignores its true nature as the best interim measure available. For the longer term, Light favoured the North Arm as the better location for developing port facilities that could only be carried out after the settlement was established and had the means to construct across mangrove swamps. After Light's death a government deal with the South Australian Company resulted in Port Adelaide being set on the Gawler Reach, north of, but closer to, the original Old Port landing place.

### **5. LIGHT'S LEGACY**

An expert report (Donovan 1998) prepared to inform the Adelaide City Council's *Adelaide Park Lands Management Strategy 1999* identified that Light's remarkable plan and Park Lands had the potential to meet six State Heritage criteria and four World Heritage criteria and World heritage potential was confirmed in 2001 by Australia ICOMOS Honorary Secretary David Jones. The benchmark set by Light for disaster risk minimization has been largely over-looked, however comparative assessments indicate his high standard compared with subsequent town-planning in Australia and elsewhere.

Surveyor-General George Goyder subsequently sought to improve accuracy and discipline in South Australia's survey department with a process like Light's methodology: topographical survey detailing the country's features, followed by marking out the best lines of road and other necessary reserves with present and future needs in mind before deciding how to conduct the detailed survey. Goyder also proposed a model town plan based on Light's plan of Adelaide, and Williams (1974) noted Light's design contributed to proliferation of 'Little Adelaide' Park Lands towns in regional South Australia. These never achieved Light's proficiency for beautifully melding landscape and urban form. Land was sometimes mapped as 'Liable to Inundation' such as Innamincka, Cooper's

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Creek, but despite Light’s examples of Adelaide and Gawler, towns were still created with insufficient reserves for watercourses, such as Jamestown’s Belalie Creek (Figure 8), thereby failing to minimise flood risk.

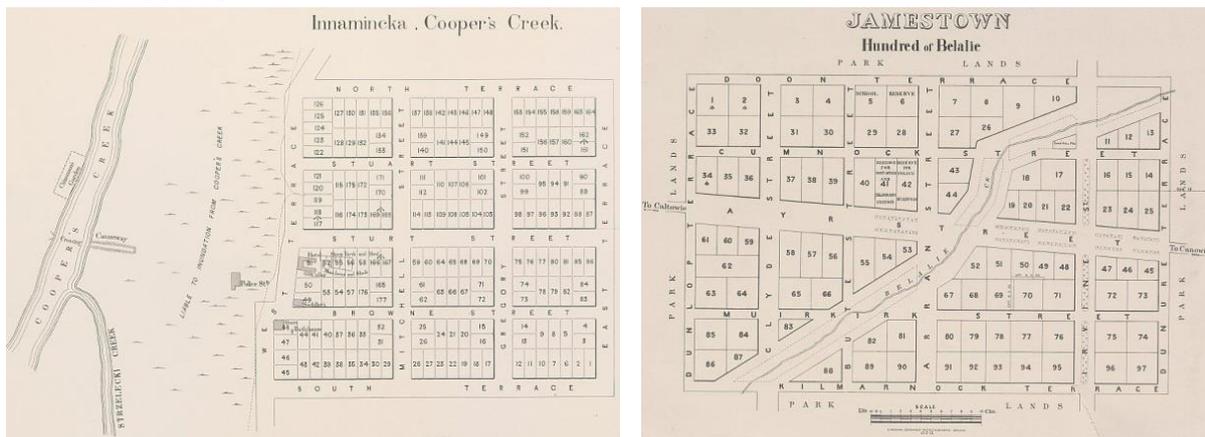


Figure 8: Innamincka, Coopers Creek (left) and Jamestown, Hundred of Belalie (right).

In recent years Australian disaster resilience and natural disaster funding studies have found governments generally overinvest in post-disaster reconstruction, and underinvest in mitigation practices that would limit impact of natural disasters (Barnes 2014:5; Australian Productivity Commission 2014:2). According to Deloitte Access Economics, by 2050 the cost of natural disasters to the Australian economy are projected to almost quadruple, to an average of \$23 billion annually (Australian Business Roundtable for Disaster Resilience and Safer Communities 2013:17). Modern scientific hydrological modelling and mapping provides striking evidence of Light’s remarkable future-proofing of Adelaide against flood disaster (Figures 9-11), and the South Australian Flood Warning Consultative Committee Study recommended a methodology to mitigate flood disaster risk identical to Light’s:

*... the most effective measure to reduce future flood damage would be based on establishing effective planning and building controls to ensure that future development does not take place in flood liable areas, or is of a flood compatible nature in areas that are flood liable. (SMEC, 1999)*

However, recent government expansion of Adelaide Oval (between the river and North Adelaide) disregards flood modelling (Figures 9 and 10). Master planning for new hospital construction on Park Lands between Trig Station A (North Tce) and the river recommended *partial* 500-year ARI flood protection, but seemingly ignored modelling for PMF / Dambreak (Figure 10), moving a hospital from an elevated site near East Tce (Royal Adelaide) to a higher risk site on lower ground, closer to the river and Adelaide Airport’s flight path.



Figure 9: Flood predictions, river valley between North Adelaide and CBD, including Adelaide Oval.

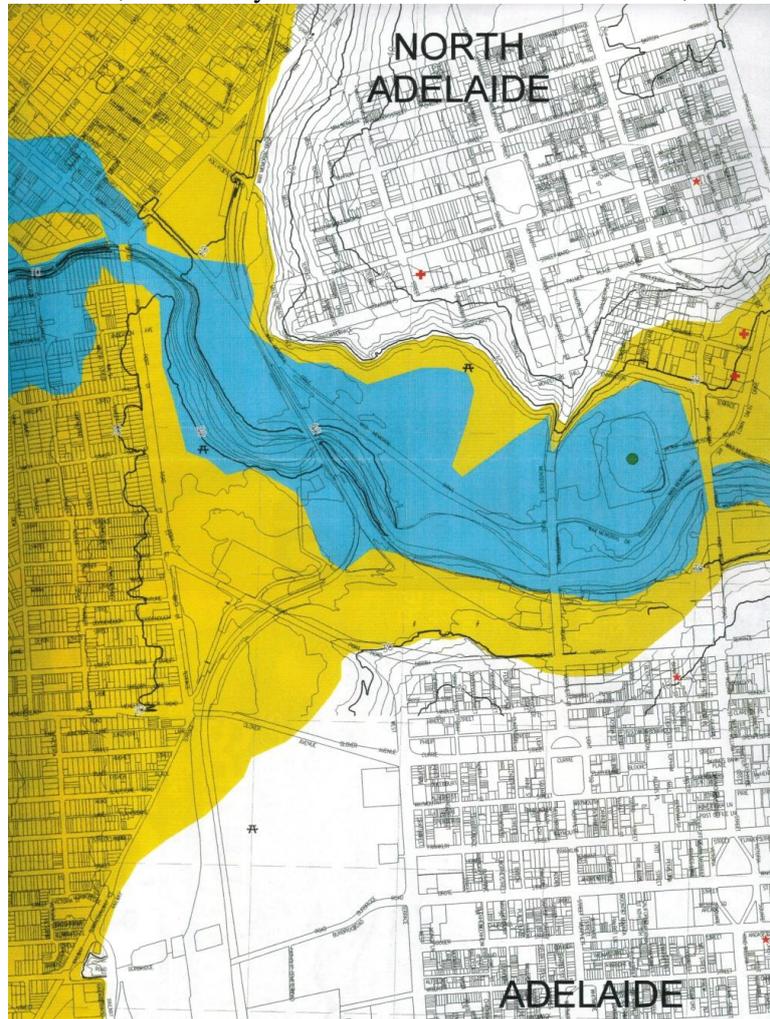


Figure 10: Modelling of PMF (Probably Maximum Flood) (blue) and Dambreak (yellow), *River Torrens Flood Inundation Mapping Study*, SA Flood Warning Consultative Committee / SMEC1999.

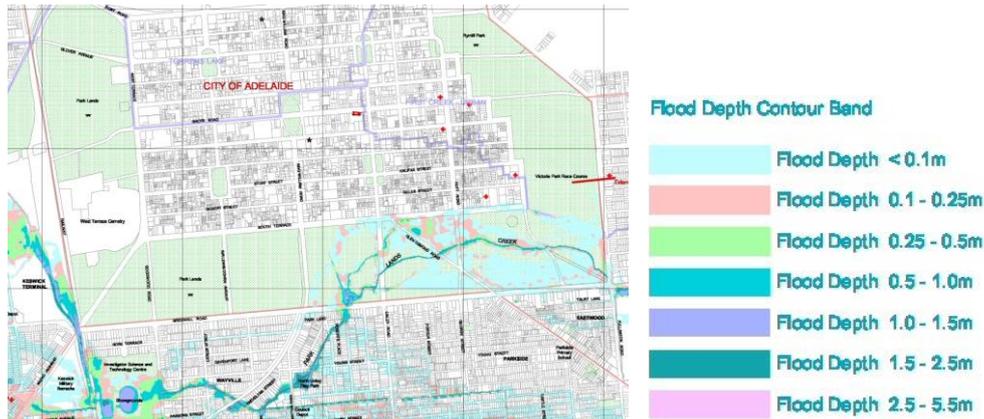


Figure 11: Brownhill–Keswick Creeks Updated 2006. Flood Plain Mapping, Flood Inundation Map 1:100 Annual Exceedence Probability Flood. Prepared by Hydro Tasmania for Brownhill–Keswick Creek Flood Mitigation Project.

Ignoring such studies and squandering Light’s legacy, government’s RenewalSA has recently branded the Torrens riverbank ‘RBPRESINCT’, and spruiks further development, including high-rise. Unsustainable misappropriation of open space Park for inappropriate development (Figures 12 and 13) has accelerated and escalated, indicating serious measures are needed to take land use and planning decisions out of the hands of politicians.



Figure 12: (left) Western elevation of new hospital, River Torrens valley, north of Trig Station A, North Tce. (right) view of North Tce blocked by riverbank construction. Photo: K. Henderson, 2015.



Figure 13: Riverbank development, Adelaide Park Lands: (left) Convention Centre expansion, (centre) Torrens Weir (foreground) / new hospital north elevation (background); (right) construction on public access reserve (Jolley’s Boathouse Restaurant). K. Henderson, 2015.

While other cities have achieved enviable environmental projects such as Cheonggyecheon's stream (Figure 14) South Australia's government has been restructuring planning laws, regulations and development plans to fast-track exploitation and environmental degradation.



Figure 14: Seoul's Cheonggyecheon area before stream restoration (left), and restoration concept.

## 6. CONCLUSION

South Australia's Colonization Commissioners provided no detailed instructions to Surveyor-General William Light for minimising risk of drought or flood, instead trusting he would strive to achieve the best possible result and relying on his experience, expertise, intelligence and good sense. In his planning of the City, Park Lands, Port and District of Adelaide Light applied sound principles that are increasingly relevant today. He provided a practical exemplar of the role of design, survey and land management in disaster risk minimisation, future-proofing Adelaide against flood and drought. Substantial historical material survives enabling a detailed knowledge and understanding of his methodology, decision-making process and surveying techniques in relation to his

- selection of the site of the town and its harbour / landing place,
- planning of the City of Adelaide and Adelaide Park, including reservation of land liable to inundation as open space, not to be constructed upon, and
- layout of the transport network and country sections of the District of Adelaide.

Light's work has ongoing value as a benchmark of excellence in sustainable development. Concerted efforts are needed by professionals and the community to restore and secure Light's planning legacy, and perpetuate its core principles.

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## **BIOGRAPHICAL NOTES**

Kelly Henderson is an Associate member of Australia ICOMOS and a life-member and former Councillor of the Royal Geographical Society of South Australia Inc (RGSSA) (2003-2009), Chairman RGSSA Geographical Heritage Committee (2004-2009), Editor of *Park Lands News* (Adelaide Park Lands Preservation Association Inc (2012-14).

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