

Academic Journal of Research and Scientific Publishing

International, peer-reviewed scientific journal

The issue eighty-sixth

Publication date: 05 June 2026

ISSN: 2706-6495

Doi: doi.org/10.52132/Ajrsp.e.2026.86

Email: editor@ajrsp.com

Dedication

It is our pleasure and great privilege to present the issue eighty-sixth of the Academic Journal of Research and Scientific Publishing to all researchers and professor who published their research in the issue, and we thank and appreciate to all contributors and supporters of the academic journal and those involved in the production of this scientific knowledge edifice.

Academic Journal of Research and Scientific Publishing

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High-recovery Inland Brine Management for California Water Resilience (Comparative Field Performance of Switchable-solvent Softening and Electro- membrane Concentration Across Five Pilot Demonstrations)

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Abstract:

This study evaluates high-recovery, non-thermal brine management strategies for inland desalination and water reuse applications in California, where water scarcity and regulatory pressures are increasing. The objective was to assess the technical feasibility and cross-site robustness of two alternative treatment pathways: (i) switchable-solvent softening coupled with membrane concentration, and (ii) electrodialysis metathesis (EDM) integrated with osmotically assisted reverse osmosis (OaRO). A mobile pilot system was deployed across five field sites treating diverse feedwaters, including brackish groundwater, reverse osmosis (RO) concentrate, municipal recycled-water brine, winery wastewater, and agricultural greenhouse brine. Site-specific pretreatment and polishing steps were incorporated as required to address variations in chemistry, including silica, organics, and scaling salts. Results show that the EDM–OaRO pathway provided the most consistent and scalable performance, achieving overall water recoveries of 84.2–98.4% across all sites and demonstrating effective control of scaling through ion-selective separation. In contrast, the switchable-solvent pathway successfully removed scale-forming salts in selected cases but exhibited strong dependence on feed chemistry and was constrained by solvent regeneration challenges, particularly flash-chamber performance and residual solvent removal. The findings demonstrate that membrane-based, non-thermal brine management can significantly reduce brine volume while increasing recoverable water, offering a viable pathway toward near-zero liquid discharge (ZLD) for inland applications. Among the evaluated approaches, EDM integrated with OaRO is identified as the most promising near-term solution for deployment across variable water chemistries, while switchable-solvent treatment remains a valuable selective pretreatment technology requiring further optimization.

Received:

29 April 2026

First Decision:

7 May 2026

Revised:

11 May 2026

Accepted:

25 May 2026

Published:

5 June 2026

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Keywords: Inland desalination; brine management; SGMA; California agriculture; electrodialysis metathesis; OaRO; switchable solvent; zero liquid discharge; water reuse

1. Introduction

California's water-supply problem is increasingly defined by the intersection of climate stress and groundwater regulation. Groundwater contributes about 41% of statewide supply in average years and up to 60% in dry years, making it the state's principal drought reserve. At the same time, the 2020–2022 period became California's driest three-year period on record, underscoring the growing volatility of the state's hydrology. SGMA, enacted in 2014, requires local agencies in high- and medium-priority basins to form groundwater sustainability agencies, develop groundwater sustainability plans, and avoid undesirable results while bringing over-drafted basins into long-term balance. (California Department of Water Resources, 2026; California State Water Resources Control Board, 2026; Water California)

For California agriculture, the consequences are structural rather than temporary. In the San Joaquin Valley, updated PPIC analysis projects that average annual water supplies for agriculture could decline by about 20% by 2040 under the combined effects of SGMA implementation, climate change, and environmental flow constraints, with nearly 900,000 acres potentially at risk of fallowing in the most constrained scenario (Escriva-Bou et al., 2023). Although local annual impacts may be larger in some basins or drought periods, the best-supported regional benchmark for a submission-ready paper is this 20% valley-scale decline.

Under these conditions, inland brackish desalination and water reuse become increasingly important. Yet inland desalination is often limited less by production of the first increment of permeate than by management of the remaining concentrate. Brine disposal and treatment remain among the principal cost and permitting bottlenecks for inland systems, especially where ocean outfall is unavailable and disposal relies on evaporation ponds, trucking, or deep-well injection (Panagopoulos et al., 2019; Tang et al., 2022). OaRO has emerged as a promising membrane-based route for concentrating high-salinity brines beyond the practical limits of conventional RO, while EDM has gained interest as a selective tool for separating scaling ions and increasing overall hydraulic recovery (Bartholomew et al., 2017; Peters and Hankins, 2019; Oddonetto et al., 2024).

The present work synthesizes five Trevi/GWI field pilots conducted in California to compare two high-recovery, non-thermal brine-management pathways: switchable-solvent softening plus OaRO, and EDM plus OaRO.

To illustrate the conceptual basis of the two treatment approaches evaluated in this study, schematic representations are provided below. These figures highlight the fundamental differences between precipitation-driven softening and electro-membrane-based ion separation for enabling high-recovery brine concentration.

Figure 1. presents the switchable-solvent-based treatment pathway, in which sparingly soluble salts are removed through selective precipitation prior to downstream concentration.

Figure 2. presents the EDM-based pathway, where ion-selective transport is used to generate a lower-salinity diluate stream and chemically conditioned concentrate streams suitable for further membrane concentration.

Fig 1. Switchable Solvent driven brine concentration (courtesy INL).

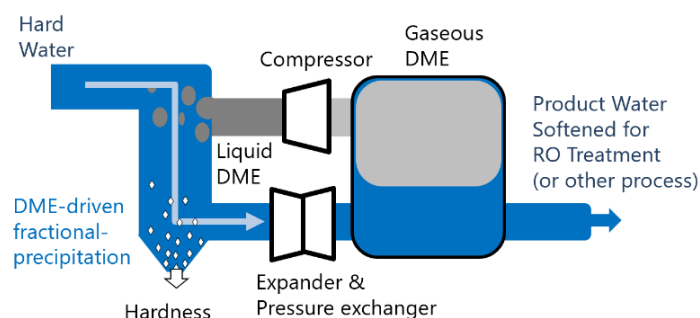
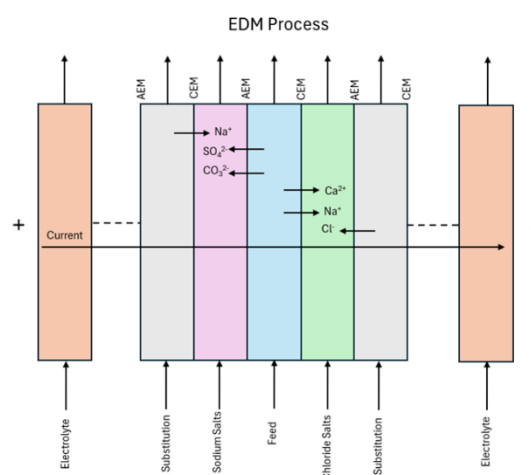


Fig 2. EDM driven brine concentration.



The objective was not merely to demonstrate technical feasibility at a single water chemistry, but to evaluate cross-site robustness under realistic agricultural, municipal, and industrial conditions. The pilots therefore provide a field basis for assessing which process route is better suited for near-term deployment in SGMA-constrained California settings.

2. Materials and methods

2.1. Pilot program overview

A mobile Trevi/GWI pilot platform was deployed at five California sites: Pleasant Valley (Coalinga brackish groundwater), San Luis Obispo (evaporation BWRO pond brine), Trinchero Winery (MBR

brine from winery wastewater), Cambria (municipal recycled-water BWRO brine), and Windset Farms (greenhouse BWRO brine). The report's stated program objective was to test whether high-recovery, non-thermal process trains could achieve 95%+ water recovery across brines spanning approximately 8,000 to 30,000 ppm with varying chemistries and scaling tendencies. The broader commercialization target was to reduce the cost of inland near-ZLD brine treatment well below conventional thermal ZLD price points.

2.2. Process configurations

Two alternative treatment trains were evaluated. In the first, RO brine or feed brine was contacted with a switchable solvent to precipitate sparingly soluble salts, primarily CaSO_4 and CaCO_3 , followed by solvent regeneration and, where feasible, OaRO concentration. In the second, EDM was used to produce a lower-salinity diluate stream and one or two concentrate streams suitable for downstream OaRO concentration. Site-specific pretreatment included ultrafiltration, degasification, silica-removal media, and final RO polishing. At Cambria, a monovalent selective electrodialysis (MSED) sub-trial was also performed.

2.3. Performance metrics

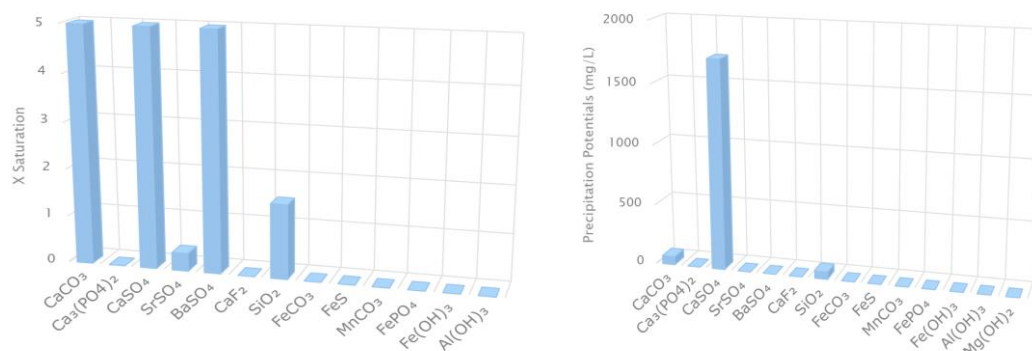
The principal response variables were overall water recovery, product-water salinity, switchable-solvent residual concentration, switchable-solvent regeneration energy, EDM CaSO_4 removal, EDM energy use, and OaRO energy use. Where late-stage OaRO was not physically run for a given switchable-solvent stream, the report explicitly identified modeled rather than directly demonstrated outcomes; those distinctions are preserved in the discussion below.

3. Results and discussion

3.1. Pleasant Valley: both trains were viable, but EDM/OaRO was more operationally robust

Pleasant Valley groundwater had relatively modest TDS of 1777mg/L and significant calcium carbonate, as well as calcium and barium sulfate scaling with the scaling indices at 5X saturation as shown in Fig 3 below. Scaling compounds are identified by first running standard scaling analysis software against a hypothetical recovery rate of 80%, then the actual RO was then operated close to the modeled 80% limit. At 77% recovery, the RO permeate measured 10 mg /L TDS.

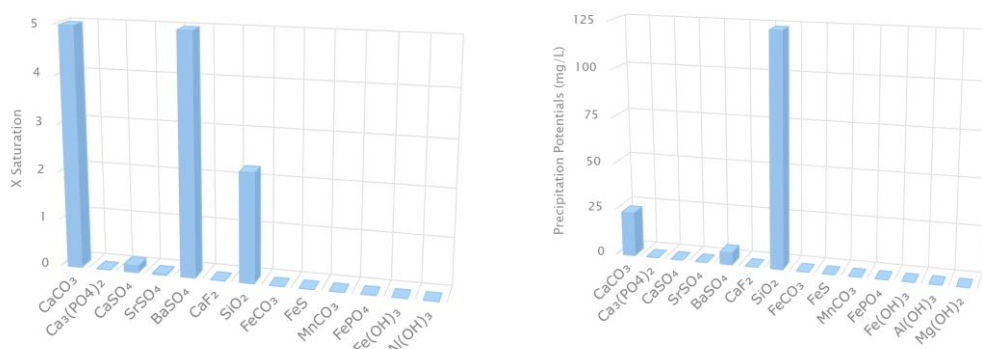
The switchable-solvent pathway removed 60% of CaSO_4 from the RO brine and achieved 98.3% overall recovery, but residual solvent remained high after the flash step and required repeated membrane-contactor DME strip passes, with projection to 5.4 mg/L only after 11 passes.

Fig 3. Pleasant Valley water @80% recovery – scaling compounds of concern.

Regeneration energy was 9.0 kWh/m³. By contrast, the EDM/OaRO pathway removed 86.5% of CaSO₄, used 0.91 kWh/m³ for EDM and 1.45 kWh/m³ for OaRO, and achieved 98.4% overall recovery with blended permeate of 216 mg/L. The site therefore showed that both pathways were technically feasible, but EDM/OaRO was simpler and less regeneration-limited.

3.2. San Luis Obispo: high silica and low hardness favored EDM over switchable-solvent treatment

The San Luis Obispo brine pond was dominated by magnesium chloride as the major constituent with relatively little precipitable hardness (calcium carbonate) and substantial silica with a TDS of 11,277mg/L as shown in the scaling analysis, at 50% recovery in Fig 4 below (limited by silica scaling). Actual RO recovery was capped near 50% because of the silica scaling risk. As anticipated, switchable-solvent treatment removed minimal scaling salts, left 4,481 mg/L solvent after a single contactor stage, and could not proceed to OaRO because the resulting stream remained silica-limited; reported regeneration energy rose to 34.3 kWh/m³. The EDM/OaRO route performed substantially better: EDM reduced the diluate from 11,277 to 1,910 mg/L, OaRO concentrated the brine to 85,170 mg/L, and overall recovery reached 84.2%. OaRO recovery to 140,000mg/L was subsequently achieved in laboratory testing, allowing recoveries to 91%.

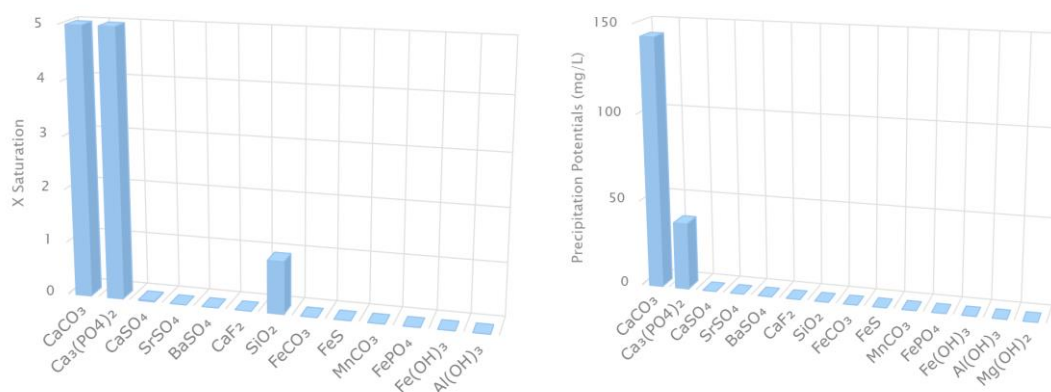
Fig 4. San Luis Obispo water @50% recovery – scaling compounds of concern.

The mechanistic advantage here was that silica remained with the diluate rather than entering the PFO concentrate stages, thereby enabling higher downstream membrane concentration. Final overall recovery was limited by the high starting salinity of the feed and single stage PFO limitation of 140,000mg/L.

3.3. Trinchero Winery: pretreatment and fouling control were decisive

Trinchero MBR waste with a starting TDS of 2103mg/L required degasification and ultrafiltration before meaningful downstream concentration as shown in Fig 5 below where calcium carbonate and calcium phosphate dominates the scaling risk. Degassing reduced carbonate from 843 to 181.5 ppm as CaCO_3 , allowing RO to run at 80% recovery with permeate in the 20–40 mg/L range. Switchable-solvent treatment was of limited value because divalent scale formers were already low and silica remained high: CaSO_4 fell only from 190.7 to 150.8 mg/L, while silica fell by only about 10%, preventing subsequent OaRO operation on that branch. Still, solvent regeneration improved materially relative to the first two pilots, reaching 746 mg/L after one contactor stage and <10 mg/L after six contactor passes, with regeneration energy of 4.59 kWh/m³ following improvements in heat recovery in the flash recovery step.

Fig 5. Trinchero water @50% recovery – scaling compounds of concern.



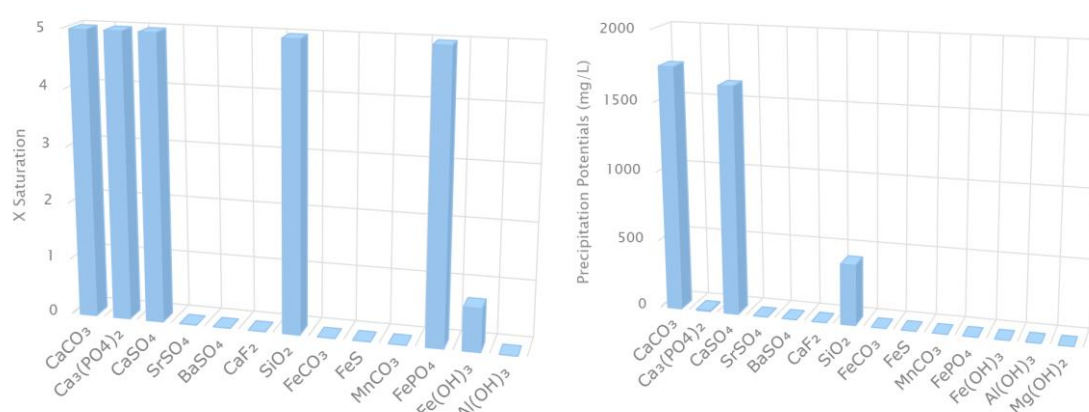
The EDM branch initially fouled because of residual polarized organics concentrated in the RO brine, but after an additional UF step the diluate fell to 220 ppm, blended product water reached 87 ppm, CaSO_4 removal was 82.0–83.3%, and OaRO concentrated the EDM concentrate streams to a combined 120,127 mg/L at 98.3% overall recovery.

3.4. Cambria: site-specific pretreatment enabled the highest-quality municipal reuse outcome

Cambria provided the strongest overall demonstration of a high-recovery municipal reuse train. Because calcium carbonate, sulfate and phosphate, as well as silica and iron phosphate were near scaling levels as shown in Fig 6 below, scaling concerns required a silica-removal media in order to

attempt RO recovery. Subsequently, softening was incorporated as pre-treatment to allow RO recovery of 50%. In Method 1, a silica removal resin reduced SiO₂ from 260 to 26 ppm, while EDM reduced feed salinity from 5,933 ppm to 42 ppm, and polishing RO was successfully operated at 99% recovery in order to meet title 22 drinking water standards for the municipality. In Method 2, which better represented typical feed conditions, silica resin removal again reduced SiO₂ to ~25 ppm, and upstream RO ran at 81.7% recovery with 20.2 ppm permeate, EDM produced a 237 ppm diluate with 98.8% CaSO₄ removal at 1.31 kWh/m³, and OaRO concentrated the two brine streams to 150,942 and 174,368 mg/L, respectively.

Fig 6. Cambria water @50% recovery – scaling compounds of concern.

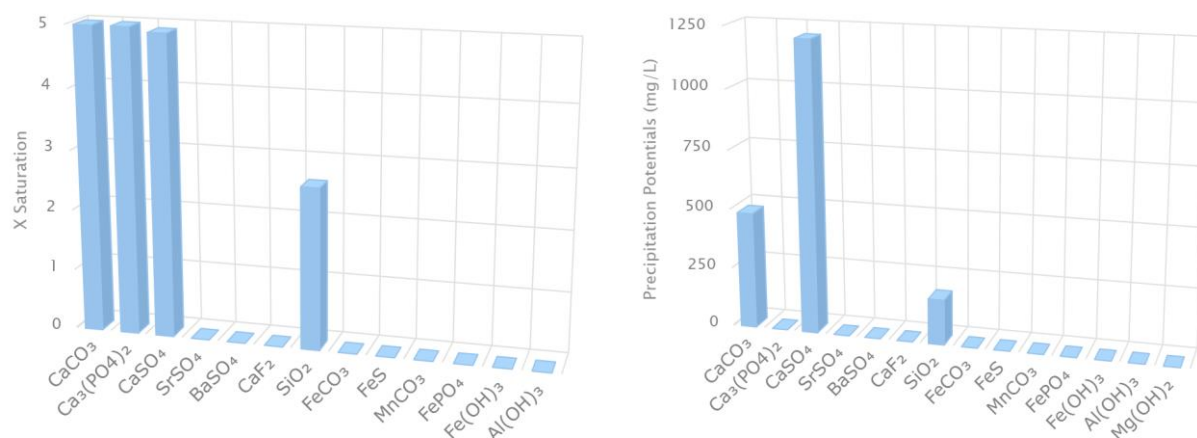


The reported overall recovery for the EDM-based route was 98.1%, with a blended product around 63 ppm after polishing. Switchable-solvent softening was effective for CaSO₄ removal, but again required multiple projected contactor stages and relied on modeled, rather than directly run data for OaRO performance in Method 2. Silica remained a concern for the OaRO membranes as it was not reduced in the switchable solvent stage, so that concentration stage was omitted.

3.5. Windset Farms: EDM/OaRO achieved high recovery, but nitrate remained the limiting constituent

Windset greenhouse RO brine at 2651 mg/L represented an agricultural case with elevated carbonate, phosphate, sulfate, silica, and nitrate contamination as shown in Fig 7 below (nitrates don't scale but are of concern in greenhouses). Switchable-solvent treatment removed 73.5% of CaSO₄ and reduced silica to 48.4 mg/L, which made OaRO theoretically feasible; however, because the full feed rather than an RO concentrate fraction was processed through the solvent system, regeneration energy rose to 29.61 kWh/m³. EDM performed well on salinity and scaling control, reducing diluate TDS to 106 ppm and removing 96.2% of CaSO₄, but nitrate in the diluate remained at 3.8 mg/L, above the <1 mg/L target for reuse as RO-permeate-quality water.

Fig 7. Windset Farms water @50% recovery – scaling compounds of concern.



OaRO successfully concentrated the two brine streams to 145,645 and 138,453 mg/L, and final RO polishing yielded 17.0 ppm TDS water. Overall recovery was 97.4%, but the product remained more suitable for well-water blending than for the more stringent nitrate target.

3.6. Cross-site comparison

Across the five pilots, the EDM-OaRO route was the more consistently industrially transferable platform. It remained effective across low- to moderate-salinity groundwater, silica-limited brines, municipal recycled-water concentrate, and agricultural RO brines. Even when energy use rose above target at San Luis Obispo and Windset, the pathway still maintained the central advantages of selective ion transfer, strong control of CaSO₄ scaling, and compatibility with downstream OaRO concentration. Switchable-solvent treatment, in contrast, was highly dependent on whether the dominant barrier to recovery was precipitable hardness rather than silica or organics. Most importantly, the limiting problem in the solvent route was not precipitation itself but solvent regeneration, especially flash-chamber performance and the number of membrane-contactor passes needed to reach the residual-solvent target. The solvent route appears more applicable to recovery of high value materials such as rare-earth elements than as a low-cost agricultural softening technology.

From a broader desalination perspective, the observed field behavior is consistent with the literature. OaRO is increasingly recognized as a membrane-compatible method for concentrating brines beyond conventional RO limits at lower energy intensity than purely thermal concentration, while EDM is attractive where ion selectivity can convert a scaling-limited brine into a more manageable concentrate stream (Bartholomew et al., 2017; Peters and Hankins, 2019; Oddonetto et al., 2024). The Trevi pilots extend that literature by showing cross-chemistry field performance rather than only lab-scale or single-site behavior.

4. Implications for California water management:

The significance of these results is sharpened by California's policy context. SGMA compels long-term reductions in unsustainable pumping, especially in the San Joaquin Valley, while drought volatility increases the value of every increment of recoverable nontraditional water. High-recovery inland desalination and reuse will only scale if brine volume can be reduced without reverting to the cost and energy burdens of conventional thermal ZLD. That is precisely the gap these pilots address. (Escriva-Bou et al., 2023; Panagopoulos et al., 2019).

For near-term commercialization, the evidence from these five pilots points to EDM integrated with OaRO, supported by targeted pretreatment, as the most bankable route. Switchable-solvent treatment remains promising, especially for sulfate- and carbonate-rich waters, but it appears better positioned as a selective front-end softening tool than as the dominant cross-site platform until solvent-regeneration hardware is further optimized. Given the solvents Class 1 Div 1 handling requirement, skilled operators impose an additional restriction on its widespread use in the field.

5. Conclusions

The five California field pilots demonstrated that non-thermal, high-recovery brine management can materially improve inland water recovery for agricultural, industrial, and municipal reuse applications. The EDM-OaRO pathway was the most robust and consistently high-performing route, delivering overall recoveries from 84.2% to 98.4% in the first two pilots and from 97.4% to 98.3% in the latter three pilots, while maintaining strong control of CaSO_4 scaling and producing highly concentrated final brines.

Switchable-solvent softening achieved meaningful scale-former removal in selected waters and showed improved regeneration performance over the course of the pilot campaign, but it remained more sensitive to feed chemistry and more constrained by regeneration-system limitations than by precipitation chemistry itself. The principal engineering priority for that pathway is therefore improved flash and polishing performance rather than proof of selective precipitation.

In California's SGMA era, technologies that reduce inland brine-management cost and increase recoverable water can help preserve agricultural productivity, sustain municipal reuse, and improve drought resilience. The present field data indicate that electro-membrane concentration integrated with OaRO is the nearer-term pathway to that outcome (California Department of Water Resources, n.d).

Based on the findings from the five pilot demonstrations, the following recommendations are proposed:

- Prioritize EDM–OaRO process trains for near-term deployment, as they demonstrated the most consistent performance across diverse water chemistries and achieved high overall recoveries with manageable energy consumption.
- Further optimize switchable-solvent regeneration systems, particularly flash-chamber design and membrane-contactor integration, to reduce residual solvent levels and improve operational efficiency.
- Implement robust, chemistry-specific pretreatment strategies, including silica removal, organics control, and carbonate management, as these were critical determinants of downstream process feasibility and performance.
- Develop site-screening criteria based on key parameters such as silica concentration, hardness, organics content, and end-use water quality requirements to guide process selection and system design.
- Advance integration with polishing and targeted contaminant removal steps, particularly for applications requiring stringent nitrate, boron, or regulatory compliance thresholds.
- Evaluate modular and decentralized system configurations to enable scalable deployment of high-recovery brine management in inland and industrial settings.
- Conduct full techno-economic and lifecycle analyses at commercial scale, including capital costs, operational expenditures, and waste handling, to validate the projected cost advantages over thermal ZLD systems.
- Explore hybrid process configurations, including integration with emerging membrane technologies, to further improve efficiency and expand applicability to higher-salinity or more complex feedwaters.

6. Acknowledgments

The authors acknowledge the support of the National Alliance for Water Innovation (NAWI) under NAWI Subcontract 7736898, as well as field-site partners and operating staff who enabled the five pilot demonstrations.

CRedit authorship contribution statement

Clark Easter: Conceptualization, Methodology, Investigation, Writing – original draft. Michael Greene: Methodology, Formal analysis, Validation, Writing – review and editing. John Webley: Resources, Project administration, Writing – review and editing. Clark Easter: Supervision, Funding acquisition, Writing – review and editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The pilot data that support the findings of this study are available from the corresponding author on reasonable request, subject to any applicable commercial and partner confidentiality restrictions. The comparative field results summarized here were derived from the five-site Trevi/GWI NAWI pilot report.

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- The California policy and drought statements in this manuscript were grounded in DWR, State Water Board, and PPIC sources, and the OaRO/EDM literature framing was grounded in peer-reviewed sources cited above. ([Water California](#))

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Doi: <https://doi.org/10.52132/Ajrsp.e.2026.86.1>

The Evolution of Friendship and Solidarity in Contemporary Fiction Set During Crisis (Normal People and Conversations with Friends by Sally Rooney)

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Abstract:

Received:

30 April 2026

First Decision:

12 May 2026

Revised:

17 May 2026

Accepted:

25 May 2026

Published:

5 June 2026

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This paper examines the evolution of friendship and solidarity in Sally Rooney's *Conversations with Friends* (2017) and *Normal People* (2018). Through comparative textual analysis, it investigates how representations of intimate relationships develop across the two novels, from the fluid and often volatile negotiations of early adulthood to a more sustained and adaptive form of interdependence. Drawing on care ethics (Gilligan, 1982; Tronto, 1993) and vulnerability theory (Butler, 2004), the study argues that Rooney portrays friendship not as effortless emotional support but as an ethical practice requiring attentiveness, responsibility, and the acceptance of mutual dependence. In *Conversations with Friends*, relationships are characterised by overlapping entanglements, power imbalances, and emotional withholding. In *Normal People*, these dynamics mature into a quieter, temporally extended form of relational autonomy, in which characters learn to negotiate class differences and personal vulnerability through repeated acts of recommitment.

By offering a sustained comparative reading grounded in feminist theory, this paper addresses a gap in existing scholarship, which has tended to analyse the novels separately or through isolated thematic lenses. It demonstrates that Rooney's early fiction reconfigures solidarity as the everyday labour of living with shared fragility under neoliberal conditions. The study contributes to broader discussions in contemporary literary studies concerning the role of the novel in articulating ethical responses to personal and social precarity.

Keywords: Sally Rooney, friendship, solidarity, care ethics, vulnerability theory, contemporary Irish fiction, neoliberalism

1. Introduction:

In an era defined by economic uncertainty, digital isolation, mental health struggles, class disparity, and relational fragility, contemporary English-language fiction has turned increasingly toward the themes of friendship and solidarity (Butler, 2004; Tronto, 1993). These bonds, once often treated as secondary to romantic individualism, now appear as essential lifelines that help characters navigate personal and collective crises. Sally Rooney has emerged as a distinctive voice in this landscape, capturing these dynamics with acuity in her first two novels, *Conversations with Friends* (2017) and *Normal People* (2018). Both works, set against the backdrop of post-Celtic Tiger Ireland and the intimate upheavals of young adulthood, portray friendship not as a static background but as an evolving force that shape's identity, exposes vulnerability, and fosters tentative forms of solidarity (Barros-Del Río, 2022; Carregal-Romero, 2023).

Rooney's novels unfold in a world where traditional structures family, stable community, and secure employment frequently falter, compelling individuals to build connections through halting conversations, shared silences, and the quiet effort of mutual understanding. In *Conversations with Friends*, the intense and fluctuating bond between Frances and her best friend (and former lover) Bobbi forms the emotional core, complicated by their involvement with the older married couple Melissa and Nick. Here, friendship intertwines with desire, jealousy, and intellectual exchange, revealing how personal crises such as illness, infidelity, and artistic ambition test loyalty while deepening interdependence. Frances's detached narration highlights the complex "texture of millennial friendship," where both digital messages and face-to-face encounters become sites of miscommunication and gradual revelation. Scholars have identified this relationship as the novel's central "interpersonal crux," where power dynamics and emotional needs constantly shift (Utter, 2021).

Normal People develop this exploration further through the long-term, on-again, off-again connection between Connell and Marianne. Their relationship, shaped by class differences, social misalignment, and profound emotional intimacy, serves as both romance and friendship in its truest sense. Amid personal crises including Connell's anxiety and depression, Marianne's history of familial abuse, and the broader alienation of university life—the pair repeatedly discover in each other a rare space of acceptance and growth. Connell gradually recognises how Marianne has helped him become a better person, illustrating solidarity as a mutual project of becoming that resists the isolating pressures of contemporary life.

This study examines the evolution of friendship and solidarity across these two novels as a way of understanding wider shifts in contemporary fiction set during moments of crisis. While *Conversations*

with *Friends* foregrounds the messy, polyphonic dynamics of chosen family among young creatives, *Normal People* trace a more longitudinal arc, showing how early bonds endure and adapt through repeated separations and reconciliations. Together, the novels move from the precarious entanglements of early twenties experimentation toward a more tempered, resilient solidarity rooted in shared fragility.

By analysing narrative techniques, character development, and thematic patterns in Rooney's early work, this paper argues that her fiction reimagines solidarity not as grand ideological commitment but as the everyday labour of listening, misstopping, and returning. In doing so, the novels present a humane vision for navigating overlapping crises through ordinary, imperfect connection.

2. Literature Review

Study on Sally Rooney's early fiction has rapidly established her as a key chronicler of optimistic experience in post-recession Ireland, with particular attention to the ways her novels interrogate relational practices under neoliberal conditions. Both *Conversations with Friends* (2017) and *Normal People* (2018) shift the focus from traditional romantic individualism toward more complex explorations of friendship, vulnerability, and interdependence, yet they diverge in emphasis and theoretical framing.

A prominent strand of criticism centres on female friendship as a central relational structure. Utter (2021) positions the bond between Frances and Bobbi in *Conversations with Friends* as the novel's "interpersonal crux," arguing that their friendship marked by former romantic attachment, intellectual exchange, and fluctuating power dynamics serves as the primary site where emotional labour and loyalty are negotiated. This reading aligns with broader feminist approaches that link Rooney's work to earlier explorations of female friendship. However, while Utter emphasises the disruptive potential of non-normative friendship, Carregal-Romero (2023) adopts a more ethically oriented lens, drawing on care ethics and vulnerability theory to examine how Frances's initial emotional detachment gives way to reciprocal openness. For Carregal-Romero, the novel critiques neoliberal subjectivities that render vulnerability an "unspeakable injury."

In *Normal People*, study has concentrated more explicitly on class, communication failures, and the long-term development of relational autonomy. Barros-Del Río (2022) reads the novel as a millennial *Bildungsroman* set in recessionary Ireland, where Connell and Marianne's on-and-off connection exposes the damaging effects of individuation and material precarity on identity formation. Class differences and social misalignments repeatedly strain their bond, yet these tensions ultimately foster growth. Carregal-Romero (2023) extends this analysis across both novels, contending that Rooney

consistently portrays vulnerability not as personal weakness but as the necessary foundation for ethical care.

These studies converge on the idea that Rooney's characters resist neoliberal ideals of self-sufficiency through practices of mutual dependence. Nevertheless, a noticeable gap remains. Existing scholarship tends to treat the two novels separately or focus on one dominant theme whether female friendship, class dynamics, or vulnerability without sustained comparative attention to how representations of friendship and solidarity themselves evolve from the experimental entanglements of *Conversations with Friends* to the more tempered, longitudinal solidarity depicted in *Normal People*. Moreover, few studies integrate care ethics and vulnerability theory with close analysis of narrative techniques and class consciousness across Rooney's diptych.

This paper addresses that gap by offering a comparative examination of the maturation of friendship and solidarity across the two novels. It positions Rooney's early work as a subtle yet significant intervention in contemporary fiction.

3. Theoretical Framework

This study is grounded in three interrelated feminist theoretical frameworks—care ethics, vulnerability theory, and relational autonomy—that together illuminate how friendship and solidarity function as ethical practices in Sally Rooney's *Conversations with Friends* (2017) and *Normal People* (2018).

Care ethics emerged as a distinct moral framework in the early 1980s, primarily through Carol Gilligan's critique of justice-based models of moral development. Gilligan (1982) identified a "different voice" that emphasises responsiveness, attentiveness, and the maintenance of relationships rather than abstract principles of rights and fairness. Joan Tronto (1993) further developed care ethics into a political and social theory, defining care as a multi-phased practice involving attentiveness to needs, assumption of responsibility, competent care-giving, and responsiveness to the care-receiver.

Vulnerability theory, as articulated by Judith Butler, complements care ethics by reframing vulnerability not as individual weakness or failure but as a fundamental ontological condition of human life. Butler (2004) argues that all bodies are precarious and exposed to injury, loss, and dependence on others. In neoliberal contexts, however, vulnerability is frequently disavowed or pathologised as a threat to self-sufficiency.

Relational autonomy provides a further conceptual bridge. Feminist philosophers such as Mackenzie and Stoljar (2000) argue that autonomy is not achieved through radical independence but is constituted and sustained through social relationships.

Applied to Rooney's novels, these frameworks reveal how characters confront the tension between neoliberal demands for self-sufficiency and the reality of human fragility. In *Conversations with Friends*, Frances's emotional detachment and the fluctuating friendship with Bobbi illustrate the difficulty of acknowledging vulnerability. In *Normal People*, Connell and Marianne's evolving bond demonstrates a gradual movement toward relational autonomy, as they learn to accept dependence and offer care across class and emotional divides.

4. Textual Analysis

Sally Rooney's *Conversations with Friends* (2017) and *Normal People* (2018) trace the shifting dynamics of intimate relationships through moments of emotional withholding, miscommunication, and gradual acknowledgment of mutual need.

In *Conversations with Friends*, the bond between Frances and Bobbi operates as the novel's central relational axis, complicated by their entanglement with Melissa and Nick. Frances's first-person narration reveals a characteristic emotional restraint. Early in the novel, she observes her own patterns of detachment, noting how she underestimates her own power in relationships "so [she doesn't] have to blame [herself] for treating other people badly" (Rooney, 2017, p. 367). When Frances's endometriosis flares and her affair with Nick strains her friendship with Bobbi, the text shows the labour required to sustain closeness. Their reconciliation scenes, marked by halting conversations, demonstrate the practice of attentiveness and responsibility central to care ethics (Tronto, 1993). As Utter (2021) observes, the friendship functions as an "interpersonal crux" where jealousy and intellectual intimacy test loyalty.

Normal People extends this inquiry across a longer temporal arc, focusing on the evolving connection between Connell and Marianne. A key passage captures their mutual shaping near the novel's close: "All these years they've been like two little plants sharing the same plot of soil, growing around one another, contorting to make room, taking certain unlikely positions" (Rooney, 2018, p. 265). This organic metaphor underscores relational autonomy (Mackenzie and Stoljar, 2000). Marianne's internal reflection further crystallises this shift: "No one can be independent of other people completely, so why not give up the attempt... depend on people for everything, allow them to depend on you" (Rooney, 2018, p. 266). Such realisations emerge from concrete crises—Connell's episodes of anxiety and depression, Marianne's isolation at university; where silence gives way to tentative recommitment.

Comparing the two novels reveals a clear development. *Conversations with Friends* foregrounds the chaotic negotiations of early adulthood, where relationships overlap and boundaries remain fluid.

Normal People shows these patterns maturing into a more sustained form of mutual shaping. Rooney's restrained prose style refuses easy catharsis, instead highlighting small acts of return and recognition.

Anchored in care ethics and vulnerability theory (Butler, 2004; Carregal-Romero, 2023), these moments illustrate how characters move from strategies of emotional self-protection toward a quieter acceptance of shared need.

5. Discussion:

The comparative analysis of Sally Rooney's *Conversations with Friends* (2017) and *Normal People* (2018) reveals a clear maturation in the representation of intimate relationships. Moving from the fluid, overlapping negotiations of early adulthood in the former to the more sustained, temporally extended bond in the latter, Rooney depicts friendship as an evolving ethical practice shaped by class tensions, communication failures, and the gradual acceptance of mutual need.

This finding extends existing scholarship in several respects. While Utter (2021) usefully identifies female friendship as the “interpersonal crux” in *Conversations with Friends*, and Barros-Del Río (2022) situates *Normal People* within the tradition of the millennial novel of formation amid recessionary Ireland, these studies tend to treat the novels in relative isolation. Carregal-Romero (2023) comes closest to a joint reading by applying care ethics and vulnerability theory across both texts, yet stops short of tracing the longitudinal development of relational practices. By offering a sustained comparative examination grounded in care ethics (Gilligan, 1982; Tronto, 1993), vulnerability theory (Butler, 2004), and relational autonomy (Mackenzie and Stoljar, 2000), the present study bridges these approaches.

A key contribution lies in showing that solidarity in Rooney's early fiction emerges less as ideological resistance and more as the accumulated result of everyday ethical labour. This nuanced portrayal challenges neoliberal constructions of autonomy while avoiding romanticised notions of perfect harmony. The textual evidence from Frances's self-reflective detachment to the organic metaphor of Connell and Marianne “growing around one another” (Rooney, 2018, p. 265) illustrates how vulnerability, once disavowed as an “unspeakable injury” (Carregal-Romero, 2023), becomes the foundation for relational growth.

Theoretically, the analysis reinforces the value of integrating care ethics with vulnerability theory in contemporary literary studies. Future research could productively extend this comparative method to Rooney's later novel *Beautiful World, Where Are You* (2021) or to other contemporary writers exploring relational ethics under conditions of precarity.

6. Conclusion

This paper has examined the evolution of friendship and solidarity in Sally Rooney's *Conversations with Friends* (2017) and *Normal People* (2018). Its central aim was to trace how representations of intimate relationships develop across the two novels, moving from experimental and often volatile negotiations in the former to a more sustained and adaptive form of mutual shaping in the latter.

The analysis demonstrates that Rooney portrays friendship not as effortless emotional support but as an ethical practice grounded in attentiveness, responsibility, and the acceptance of vulnerability. Drawing on care ethics (Gilligan, 1982; Tronto, 1993), vulnerability theory (Butler, 2004), and relational autonomy (Mackenzie and Stoljar, 2000), the study shows how characters in both novels gradually shift from strategies of emotional self-protection toward practices of recommitment and interdependence. Key moments such as Frances's reconciliation with Bobbi and the organic metaphor of Connell and Marianne "growing around one another" (Rooney, 2018, p. 265) illustrate that solidarity emerges through small, repeated acts of negotiation rather than grand ideological commitment.

By offering a sustained comparative reading of the two novels, this study extends existing scholarship, which has largely examined the texts separately or through singular thematic lenses (Utter, 2021; Barros-Del Río, 2022; Carregal-Romero, 2023). It contributes a more nuanced understanding of how Rooney's fiction reconfigures relational ethics under neoliberal conditions.

Ultimately, the study suggests that contemporary literature continues to serve as a vital space for exploring humane responses to personal and societal crisis. Rooney's early novels affirm that imperfect human connections, forged through miscommunication and return, remain one of the most significant resources available in an age of increasing precarity.

7. Recommendations

This study's examination of friendship and solidarity in Sally Rooney's *Conversations with Friends* and *Normal People* opens several promising avenues for further research and application. Future research could productively extend the analysis to Rooney's later fiction, particularly *Beautiful World, Where Are You?* (2021), to determine whether the trajectory toward more resilient and ethically grounded forms of interdependence continues or encounters new complications amid evolving personal and global crises. Such an extension would allow for a fuller diachronic mapping of relational dynamics across her oeuvre, tracing how her characters negotiate care ethics and vulnerability under intensified conditions of political awareness, climate anxiety, and pandemic-era isolation.

Comparative studies would also enrich the field. Placing Rooney's work alongside other contemporary explorations of friendship such as Elena Ferrante's Neapolitan novels, or the fiction of

British and Irish writers like Sally Rooney's contemporaries (e.g., Naoise Dolan or Colin Barrett) could illuminate both shared millennial sensibilities and distinct cultural inflections. Additionally, examining Rooney's novels in dialogue with non-fiction accounts of friendship and solidarity in post-Celtic Tiger Ireland, or with sociological studies of neoliberal subjectivity, would deepen the interdisciplinary potential of this framework. Another fruitful direction lies in the mediation and adaptation of these themes. Given the immense popularity of the television adaptations of both novels, research might investigate how visual and performative media translate (or transform) the subtle textures of communication failure, embodied vulnerability, and quiet recommitment that characterise Rooney's prose. Such analyses could explore whether screen portrayals reinforce or dilute the ethical force of solidarity as an everyday practice of care.

From a broader applied perspective, the insights generated by this research hold relevance for fields beyond literary studies. Educators and mental health practitioners working with young adults might draw on Rooney's nuanced depictions of relational autonomy and vulnerability to foster discussions around emotional interdependence, class-inflected shame, and the value of imperfect but sustained connection. In an age of widespread loneliness and digital disconnection, Rooney's fiction offers valuable literary resources for reflecting on the quiet labour required to maintain solidarity amid uncertainty.

Finally, future work should continue to interrogate the political and ethical stakes of everyday friendship in contemporary literature. By foregrounding care ethics and vulnerability theory, scholars can further challenge neoliberal narratives of self-sufficiency and contribute to wider cultural conversations about what forms of human connection remain possible and necessary in times of overlapping crises.

This study, while focused on two foundational texts, thus serves as an invitation to deeper and wider explorations of how contemporary fiction reimagines solidarity not as utopian ideal but as an imperfect, tenacious, and ultimately sustaining practice of being-with-others.

8. Acknowledgement

The author of this paper would like to acknowledge that this study was conducted independently without any external funding or financial support. No grants were received from public, commercial, or not-for-profit funding agencies. The author also confirms that there are no conflicts of interest, financial or otherwise, that could have influenced the research process, interpretation of sources, or presentation of findings. All views expressed in this article are solely those of the author.

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Doi: <https://doi.org/10.52132/Ajrsp.e.2026.86.2>